samoa Daily news

Today's paper includes "B" and "C" sections

PAGO PAGO, AMERICAN SAMOA FRIDAY, NOVEMBER 1, 1991 50¢

God made the fish ... it's still safe to eat, protests local fisherman

"God made the fish... it's still safe to eat." That's the explanation given by an elderly subsistence fisherman when asked why he was still fishing in Pago Pago Harbor. He said that he knew about the government advisory telling people not to eat fish caught in the inner harbor, but he did not take notice of it because he had been fishing most of his life in the area and none of his family ever got sick from eating his catch.

At the Star Kist dock on a wet Wednesday morning, six fishermen in two aluminum skiffs are reeling in their lines. One shows off his prized catch for the morning, a three pound "jack" *(tafala)*. Perched on the deck of purse seiners and Oriental longliners alongside the cannery dock, about eight other young fishermen are waiting to feel a pull at the end of their lines.

"Have you read the notice that fish caught in the harbor is not safe for eating?" I ask the oldest of the fishermen, a stocky built man, about 50 years old. He's cutting up what looked like an *aku* and throwing the pieces into the dark green, colored water. "Yes, I've read the notices," replies the fisherman."

"Then why are you still fishing here?" I asked in response. He stated that no-one in his family has been sick from eating the fish. In the second boat, the fisherman who landed the two silver jacks calls out that they don't sell their catch, that they only feed their families with the fish they haul in (this is what is known as "subsistence"). A bunch of *misiluki* bananas and a cooler sit between the two fishermen in this second skiff.

After some urging, one of the younger fishermen on board replies that he's read the health advisory telling people that fish caught in the inner harbor is not safe to eat, but he's not taking any notice of it. He assures that he doesn't sell his catch and that none of his children have fallen ill from eating the fish he puts on the table.

I try to explain that tests have shown that fish caught in the area between the Rainmaker Hotel and Leloaloa contain poisonous (toxic) substances which can make them sick, maybe not now but in the future. I ask them why they don't try fishing somewhere else and I just get a blank look. "If you love your kids, don't feed them that fish," I call out. Before our alia takes off, one of the fishermen assures that they'll think carefully about the health warning.

What we had stumbled on was an everyday happening which has continued unimpeded in spite of the recent warnings not to eat fish in the harbor... a practice which, from all indications, will take many years and a major public education effort, to stop.

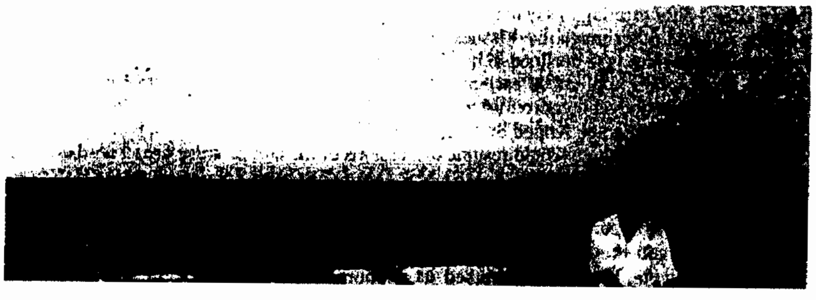
(It is not illegal to fish in the inner harbor, nor to eat the fish caught there. As explained below, the government has informed commercial establishments, such as bush stores, that it is a violation of law to sell fish from the inner harbor.)

How do you tell someone who has depended on the sea for food that they can no longer fish in a certain usual area because the water is so full of poisons that the fish have also turned bad?

The fish still look okay, they're not dead so they must be safe to eat, traditional fishermen reason. How are they to know about the delayed effects of the invisible lead, oil, PCB and other toxins in the waters they've fished in for years?

The fishermen in the skiffs we saw that morning were probably part of a growing fleet of small scale commercial fishermen. Before the fish advisory was issued, the fleet was selling their catches to bush stores and restaurants around the island, with the bulk going to Bay Area establishments. Since the warning

(Continued on page 9)



* FISH

from page one

came out, they've had a hard time selling their catch. The Enforcement Unit of the Department of Marine and Wildlife Resources has warned vendors that they face stiff fines if they knowingly sell fish caught in the inner harbor.

A DMWR spokesman said that all vendors known to have bought fish from the inner harbor fleet are no longer doing so. He said that enforcement officers are periodically patrolling bush stores and restaurants known to sell harbor fish and so far they've received very good co-operation. What's worrying DMWR and Public Health officials however is that the fishermen are peddling their susceptible catches elsewhere. They've advised the public to be cautious of buying locally caught fish and always ask the sellers where their fish was

Government agencies charged with the responsibility of informing the public about the consequences of eating inner harbor area fish have started to get the word out, about the possible health hazard from inner harbor fish almost three months after the U.S. Environmental Protection Agency suggested to ASG that it issue a health advisory about the potential

(Scientists have not yet collected enough data to prove beyond doubt that fish caught from the inner harbor are so filled with toxins that they will make people sick. But preliminary scientific analysis indicates that "70-80 of the children consuming contaminated [inner harbor] fish could have a blood lead concentration... where IQ levels can be permanently and adversely affected.")

The Governor's Office has issued two press releases and a warning notice is being published twice a week in the local newspapers. Leaflets are also being distributed to Bay Area fishermen and residents. According to government officials, the awareness campaign will include television and radio and village visitations (e.g., with village councils and pulenu'u), but these elements of the campaign have not yet begun.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

June 7, 1991

MEMORANDUM

SUBJECT: Review of Pago Pago Harbor Toxicity Study

FROM: Norman L. Lovelace, Chief (E-4)
Office of Pacific Island and Native American Programs

TO: Stephanie Wilson, Acting Chief (W-7-1)
Oceans and Estauries Section

This is to request your office's assistance in reviewing the attached draft report on the Pago Pago Toxicity Study for the American Samoa Environmental Protection Agency. The first phase of the report was originally reviewed by Dr. Brian Melzian last summer, and his timely and detailed comments were greatly appreciated and incorporated into the second round of analyses conducted. We understand from Dr. Melzian that because of pressing projects he will not be able to review the study in-depth until early July. However, should other staff from your section review this study, he said he would be able to discuss with them any specific points of concern they might have during his trip to the Region the third week in June. (There is no pressing urgency for this review although a response by August would be appreciated by ASEPA.)

I have also forwarded a copy of this report to Arnold Den who will look at the study from a risk assessment viewpoint.

We greatly appreciate your assistance in this matter. Should you have any questions, please call me at 4-1599 or Pat Young at 4-1591.

Attachments (2 copies)

cc: Brian Melzian (w/o attachment)
Pati Faiai, ASEPA

ROUTING AND TRANSMITTAL SLIP

Date 11/17

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. Dave Stuart 10-7-1		
2.		
3.		
4.		
5.		

	Action		File		Note and Return
	Approval		For Clearance		Per Conversation
	As Requested		For Correction		Prepare Reply
	Circulate		For Your Information		See Me
	Comment		Investigate		Signature
	Coordination		Justify		

REMARKS

Dave - I talked to Steve Costa briefly about the additional model - he doesn't know at this time what he's going to use - would be contingent on data - but he has several in mind. He will include in study plan that he will submit this model for our review when he selects/develops it.

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)	Room No.—Bldg.
Pat Young	Phone No.

5041-102

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

December 10, 1993

Steven L. Costa
Project Manager
CH2M Hill
P.O. Box 12681
Oakland, CA 94604-2681

Re: Comments to Draft Study Plans for Joint Cannery Ocean Disposal Bioassay Toxicity Tests and Modeling Re-evaluation

Dear Steve:

We have reviewed the draft study plans for the biotoxicity tests and modeling re-evaluation. Attached are comments on the bioassay toxicity tests which should be addressed before the plan will be approved. Questions regarding these comments should be addressed to Amy Wagner at (510) 412-2329. A final study plan should be submitted for approval upon resolution of these comments.

Due to the delay in submittal of the draft study plan, we are allowing the first sampling episode to occur in January 1994, rather than in November 1993, as indicated in the ocean disposal permits. Thus we approve your request that each of the subsequent three sampling episodes be delayed by the same amount to maintain the desired spacing. However, the completion date for the overall study will not be changed.

The modeling re-evaluation study plan is approved as submitted. However, as we previously discussed, the additional, more sophisticated model referenced in the plan has not been selected yet and will be submitted for EPA's review prior to its utilization.

Please call Pat Young at 415/744-1594 if you have any questions.

Sincerely,

Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

cc: Jim Cox, Van Camp Seafood Company
Norman Wei, StarKist Seafood Company
Tony Tausaga, American Samoa EPA
Sheila Wiegman, American Samoa EPA

Attachment

bc: Robyn Stuber/Debra Denton, W-5-1
Dave Stuart, W-7-1
Mike Lee, E-4
Amy Wagner, P-3-1
Allan Ota, W-7-1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

DEC 09 1993

SUBJECT: Review of Draft Bioassay and Modeling Re-evaluation Plans for Tuna Cannery Ocean Disposal Permits

TO: Pat Young
American Samoa Program Manager

FROM: Amy Wagner
Laboratory Section

Debra Denton, Permits Issuance Section, and I have reviewed Part I (Bioassay Toxicity Tests) in the above entitled document. We do not recommend approval of the plan until the following issues are addressed or considered. Any questions concerning these comments can be adressed to me at (510) 412-2329.

1. Introduction, I-1: Considering the nature of the waste discharge, we agree that the fish processing wastes should be considered as whole effluent and not tested in the suspended particulate phase.

2. Sample Shipping and Handling, page I-2: Understanding the logistical difficulties in shipping samples from the South Pacific, it should be recognized that a 10 day hold time could result in an increase or decrease of toxicity. It is likely that the BOD will increase over time as reflected by IDOD values determined in the last toxicity tests on cannery effluent. Every effort to minimize the hold time should be made.

3. Selected Species, page I-2: _Holmesimysis costata_ may not be an appropriate surrogate crustacean due to the low test temperature required and the crustacean's sensitivity to aeration. The use of the 96-hour static renewal acute test with _Mysidopsis bahia_ is recommended as a more representative tropical species relevant to the study area.

4. Sample Preparation, page I-4: Artificial sea salts for brine manipulations of effluents can often cause toxicity. Use of natural seawater brine effluents (obtained from freezing or evaporating natural seawater) is recommended.

5. Experimental Conditions, I-4: The dilution series proposed seems more appropriate than the permit requirements based on toxicity seen at low concentrations of the cannery effluent. This dilution series may have to be modified after the first round of testing.

6. Experimental Conditions, I-5: The test temperatures proposed for the crustacean and sea urchin bioassays are higher than standard method requirements. Tests with _M. bahia_ and _P. vannamei_ are run at 20C, while tests using _S. purpuratus_ are normally run at 12-15C.

7.Experimental Conditions, I-5: Methods for fish, mysid, and sea urchin toxicity tests should be cited (manual or reference) in this section since all test conditions (ie. static renewals, number test organisms) are not listed.

8.Quality Control and Quality Assurance, I-5: Sodium chloride is not a standard reference toxicant used in marine fish and mysid tests. In addition, this salt may cause an osmoregulatory rather than a toxicity response in the test organism causing variable sensitivity and dose-responses. Sodium dodecyl chloride, copper sulfate, or zinc sulfate are recommended reference toxicants for these test organisms.

cc: Terry Oda, Chief
Permits Issuance Section (W-5-1)

CH2M HILL

Engineers
Planners
Economists
Scientists

NOV 15 1993
RECEIVED

November 12, 1993

PDX30702.DS.BP/.MP

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: **Draft Study Plan for Special Condition 3.3.5 Ocean Dumping Studies for StarKist and Samoa Packing, American Samoa**

Enclosed is a draft study plan for the bioassay and modeling re-evaluation studies required under the ocean dumping permits for the two canneries. We have suggested an alternative species for the Group 1 bioassays for reasons presented on page I-3 of the draft study plan. Because of the delayed submittal of the study plans it may be necessary to delay the first sampling if the study plan cannot be reviewed quickly or substantial changes are required. I do not see this as a problem and suggest delaying each of the three sampling episodes by the same amount to maintain the desired spacing. This will not delay the completion of the overall project. We can delay the sampling by up to two months or more and still finish the study well ahead of schedule.

Please call me if you have any questions. Comments should be addressed directly to me and copied to Norman Wei and Jim Cox. I have sent Sheila Wiegman at ASEPA the same information.

Sincerely,

CH2M HILL

Steve Costa

Steven L. Costa
Project Manager

cc: Norman Wei/StarKist Seafood Company
James Cox/Van Camp Seafood Company

CH2M HILL 1111 Broadway, P.O. Box 12681, Oakland, CA 94604-2681 510 251-2426 Fax 510 893-8205

DRAFT STUDY PLAN

FOR

JOINT CANNERY OCEAN DUMPING STUDIES

IN

AMERICAN SAMOA

Prepared for

StarKist Samoa
(Permit OD 93-01 Special)

and

VCS Samoa Packing
(Permit OD 93-02 Special)

Prepared by

CH2M HILL

11 November 1993

STUDY PLAN
FOR
JOINT CANNERY OCEAN DUMPING STUDIES
IN
AMERICAN SAMOA

Special ocean dumping permits have been issued to StarKist Samoa, Inc. and VCS Samoa Packing, Inc. because the Regional Administrator of EPA Region IX has determined that disposal of fish processing wastes off American Samoa meets EPA's ocean dumping criteria at 40 CFR Parts 227 and 228. Special condition 3.3.5 of both permits requires bioassay testing of the waste from each cannery and a re-evaluation of the model previously used to predict concentrations of fish processing wastes disposed of at the designated site. A copy of this special condition is provided in Appendix 1 of the study plan.

The special permit condition addresses two distinct efforts: bioassay testing and model re-evaluation. Although the results of the bioassay testing will be used in the final steps of the model re-evaluation, the two parts of the study are quite different and are best described independently. Therefore, this study plan is presented in two parts:

- Part I: Plan of Study for Bioassay Toxicity Tests
- Part II: Plan of Study for Modeling Re-evaluation

The two portions of the study will be conducted independently except as noted above. References are provided separately for part of the study plan. Additional information is provided in Appendices.

Part I

PLAN OF STUDY FOR BIOASSAY TOXICITY TESTS

INTRODUCTION

Under special conditions 3.3.5 of the Ocean Disposal Dumping Permits, StarKist Samoa and VCS Samoa Packing are required to conduct and submit the results of toxicity tests on fish processing wastes generated at the permittees' American Samoa packing plants. The toxicity tests are to be initiated within 10 days following sampling on November 30, 1993, February 28, 1994, and May 31, 1994. The wastes to be tested include DAF sludge and other high strength waste streams that are barged to sea for disposal at the permitted dump site. This part of the study plan describes the methods proposed to conduct the bioassay tests. The results of the tests will also be incorporated into the modeling re-evaluation described below in Part II of the study plan.

General guidance for these tests is provided by USEPA (1991), ASTM (1992), and the EPA/COE "Green Book" (1991). Specific guidance for performing biological-effects tests for Ocean Disposal permits are outlined in Part III, Section 11 of the Green Book; *Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual* (EPA and COE, 1991). However, the fish processing wastes to be disposed under this permits are not similar to solid dredged materials. The high strength waste materials are mostly liquid phase wastes which are positively to neutrally buoyant with a small fraction of negatively buoyant solid particles. This waste is not expected to behave in a fashion typical of solid, generally negatively buoyant, dredge spoil material when disposed of by dumping at sea. Therefore, the physical and chemical nature of the wastes requires modifications to the suspended bioassay tests as outlined in the Green Book.

The following Methods sections include the specific modifications required to properly evaluate the toxicity of the tuna cannery high strength wastes. A description of the proposed reporting schedule and format for the bioassay test results is provided in the Reports section.

SAMPLING METHODS

Sample Composition

High strength waste samples will be collected at each cannery from the existing sampling ports in the storage tank transfer lines. Three samples will be taken at 10 minute intervals while waste is being transferred from the storage tanks to the barge. Samples for the bioassay tests will be composited from the three discrete samples. Waste from each cannery will be collected and shipped separately and shall not be combined.

Sampling Times

Sampling will be conducted on the following days, if possible:

- Tuesday, November 30, 1993
- Monday, February 28, 1994
- Tuesday, May 31, 1994

If a cannery is shut down, or material is not being transferred to the barge on that day, sampling will be done at the first available time.

Sample Shipping and Handling

EPA approved chain-of custody, sample shipping and handling, and record keeping will be conducted to preserve and monitor the integrity of the samples used for the required bioassays. Samples will be cooled at the canneries after collection and then packed in ice for shipment. The permit requires tests will be initiated within 10 days of sample collection. There are significant and well recognized problems with shipment of material from American Samoa. Every reasonable effort will be made to meed the required 10-day maximum holding time. If the holding times are exceeded for some reason, EPA Region IX will be contacted to determine if the tests should be initiated or if new samples should be collected and shipped.

TEST METHODS

Selected Species

The permit condition requires testing of three species selected from three groups listed in section 3.3.5 of the permit. We propose tests be conducted with the pacific mysid shrimp (*Holmesimysis costata*) juveniles, pacific sanddab (*Citharicthys stigmaeus*) juveniles, and purple sea urchin (*Strongylocentrotus purpuratus*) larvae. These species and life stages were chosen because they represent sensitive crustacean, fish, and zooplankton components of the marine community, tolerate laboratory conditions, and can be readily tested as young life-stages. These species are also routinely used in conducting bioassays for the ocean disposal permit program. Of great importance are the practicality and year-round availability of the appropriate life-stages of all three of the above species.

The shrimp and fish species were selected from the lists (Group 2 and Group 3, respectively) specified in the permit special condition. The sea urchin species (*Strongylocentrotus purpuratus*) was not listed in the permit (Group 1). We have recommended a different species because it is important that the same species and life-stages be used for each test series conducted. Three test series of bioassays will be conducted over approximately 9 months. The rationale for recommending a different species is as follows:

- The mollusc species listed in Group 1 (*Mytilus* sp. and *Crassostrea* sp.) and the copepod (*Acartia tonsa)* are potentially difficult to obtain at the appropriate life stage at all of the times specified in the permit condition.

- Therefore, sea urchin larvae, also listed in Group 1, are proposed for these tests instead of mollusc or copepod because of their availability at all times of the year.

- However, the sea urchin specifically listed (*Trypneustes* sp.) is not readily available and may be difficult to obtain, particularly at the specific times as required in the permit and an alternate sea urchin species (*Strongylocentrotus purpuratus*) is recommended.

With a limited number of opportunities to evaluate the toxicity of the material to be disposed, it is important to compare the results of bioassay tests using the same species and life-stages.

If necessary, *Mytilus* sp. (mussels) will be used as a backup species to the sea urchin and white shrimp (*Paneaus vannamai*) will be used as a back-up test species for the mysid shrimp should the primary test species be unavailable at the time of the bioassays. All reasonable efforts will be made to consistently use the primary test species.

Acclimation and Holding

All test organisms will be brought into the laboratory and gently acclimated to test conditions and control water (dilution water) for a minimum of 24 hours prior to test initiation. Salinity, temperature, and dissolved oxygen conditions during test organism holding and acclimation will be monitored to ensure proper acclimation is obtained prior to starting the bioassay tests.

Sample Preparation

Properly refrigerated wastewater samples will brought up to test temperature prior to further test solution preparation. If the salinity of the waste solution is greater than 2 grams per liter less than that of the disposal site receiving water, salinity of the test waste solution will be adjusted with anhydrous sea salts up to the receiving water salinity. Time will be allowed for waste solution pH and salinity equilibration prior to bioassay initiation. Similarly, test control water will be adjusted to appropriate test salinity prior to test initiation.

Initial dissolved oxygen demand (IDOD) has been determined to be a problem with cannery effluent and high strength waste streams. Preliminary IDOD measurements were done at the canneries in October of 1993. The results are given in Appendix 2 of the study plan. IDOD determinations will be conducted and recorded for the samples prior to the start of the bioassays. The results of these IDOD measurements will be used to determine sample dissolved oxygen (DO) conditions and aeration procedures required for the bioassays.

Experimental Conditions

Serial dilutions using filtered natural seawater obtained from the Bodega Bay Marine Laboratory, California will be prepared by volumetric addition of diluent and high strength waste effluents from each cannery. Glass graduated cylinders and other non-contaminating labware will be used to prepare the test solutions. The permit condition requires dilutions of 100, 75, 50, 25, 10, and 5% waste concentrations, as well as a control. Based on previous bioassay results for both the high strength wastes and the joint cannery effluent discharged through the outfall, we recommend that the dilutions used be concentrations of 50, 25, 10, 5, 2.5, 1.25, 0.62, and 0.31 % waste. Control water consisting of diluent water only will also be tested. Five replicate test vessels will be prepared for each test solution and control.

Test vessels will be maintained in controlled temperature incubators or water baths and allowed to acclimate to test conditions prior to the test initiation. Temperature, salinity, pH, ammonia and DO will be measured prior to test organism assignment into the test vessels. If DO concentrations are less than 40-percent of saturation or less than 4 mg/liter in any test solution or control, aeration will be initiated sufficient to maintain adequate DO levels in all test vessels and in all test concentrations (and controls) to maintain DO concentrations at a levels sufficient to support the organisms. Test photoperiod will be controlled by automatic timers to ensure adequate light for the bioassays.

Test temperatures for the fish, crustacean, and sea urchin bioassays will be 15, 15 and 18 degrees celsius respectively. Salinity for these tests will be that of the receiving water at the disposal site. Test organisms will be randomly assigned into the test vessels. Test vessels will be covered with loose fitting glass or non-contaminating covers and placed into the temperature controlled incubators.

The bioassays will be conducted for 96 hours (4 days). Daily observations to enumerate live fish and mysids and to monitor water quality parameters will be conducted throughout the bioassays. Equal volumes of food will be added to only the mysids to reduce cannibalization of this species within the test vessels.

The effect measured in the fish and mysid bioassays is mortality as defined as: no observed movement exhibited by the test organism after gentle swirling of the test container or probing. The test endpoint for the sea urchin larvae bioassay is mortality and/or larval abnormality as compared to the control organisms.

QUALITY CONTROL AND QUALITY ASSURANCE

The quality assurance objective is to characterize the potential toxicity of each of the canneries high strength waste to marine organisms by collecting bioassay test data of known and acceptable quality. The qualifications of the laboratory and personnel conducting the tests is provided in Appendix 3. The procedures described in the Test Methods section above describe the QA/QC procedures for sampling, analytical procedures, equipment calibration, sample custody, and data reduction and analysis.

Mortality in the controls of less than 10-percent in the fish and crustacean tests and 30-percent in the sea urchin tests after 96 hours will indicate successful tests. If these criteria are not met then EPA will be consulted to determine whether additional tests should be considered. Concurrent reference toxicant tests with the fish and mysid test species will be conducted using sodium chloride and reference toxicant tests with the sea urchin will use copper sulfate solutions with test concentrations bracketing the known acute toxic concentration (LC50) for each species tested. These tests will be conducted for a 24 hour duration. If the concurrent reference toxicant test LC50 falls within ±2 standard deviations of the testing laboratory's cumulative sum LC50 for that species the tests will be considered acceptable.

DATA ANALYSIS AND REPORTING

Test data analysis and calculations

Acute mortality and/or larval abnormality data will be used to calculate an acute median lethal (LC50) or effect (EC50) concentration. A computer program (TOXDAT) will facilitate the calculation of the 96 hour LC50 (or EC50 for the zooplankton tests) by either: Probit, Spearman-Karber, or the Trimmed Spearmean-Karber Methods. The analysis used will depend on the distribution of the mortality data obtained from these toxicity tests. These LC50 or EC50 values will then be used to calculate Limiting Permissible Concentrations (LPC's).

Reports

A report of the results of the bioassay tests will be prepared following each of the tests. The report format will be as described in the permit conditions (Sections 3.3.5.1 through 3.3.5.5). Specific information including bioassay materials and methods, sampling procedures, results, data analysis, and discussion will be included in the report. General guidance for the bioassay reports will be that of EPA (1991).

REFERENCES

American Society for Testing and Materials, ASTM. 1992. Standard Practice for Conducting Static Acute Toxicity Tests with Embryos/Larvae of Four Species of Saltwater Bivalve Molluscs. Designation E724-92. Annual Book of Standards, Vol:11.04. ASTM, Philadelphia, PA.

United States Environmental Protection Agency. 1991. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms. Fourth Edition. EPA/600/4-90/027. September 1991. 293 pp.

United States Environmental Protection Agency, United States Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual. EPA-503/8-91/001. February, 1991.

Part II

PLAN OF STUDY FOR MODELING RE-EVALUATION

INTRODUCTION

Permit condition 3.3.5 of the Ocean Disposal Dumping Permits for StarKist Samoa and VCS Samoa Packing requires that the bioassay results be used re-evaluate the previous model predictions of dispersion of the plume created by dumping fish processing wastes at sea. The previous predictions are presented in the FEIS (EPA, 1989) and in a supplementary study (SOS, 1990). A field study of the fate of the wastes is described by Soule and Oguri (1983). A description of the previous model and the details of the past modeling results are found in Appendix B of the FEIS.

We propose to conduct the model re-evaluation in three phases:

[1] The existing model formulation, as described in the 1989 FEIS (Appendix B) will be used "as is" with model predictions evaluated using the new bioassay test results. Any differences in conclusions between earlier work and the reevaluation will be presented and discussed.

[2] The input data and assumptions used in the model will be examined and evaluated. Sensitivity studies will be done for critical parameters, including assumed values for diffusion coefficients, initial dilution, and ambient conditions. The appropriateness and applicability of previously assumed values will be discussed.

[3] A different, more sophisticated model(s), and/or modifications to the previous model, using appropriate assumptions, will be applied as an independent check of the previous model predications. The model selection will be based on the results of step [2] above. The objectives of the re-evaluation with a different model is to account for changes in vessel characteristics and operational methods and to develop a more representative model.

The previous model, based on an approach originally developed by Norman Brooks, is typically very conservative in similar applications. Other assumptions in the model are also conservative. The use of a different or modified model will allow an evaluation of the degree of conservatism being applied. The initial dilution assumptions will also be examined. The propeller stream of the vessel will be modeled, using an established model developed at Texas A&M and modified by CH2M HILL, to assess the actual degree of the initial mixing. Conclusions and recommendations will be presented based on the independent assessment. The three phases of the model re-evaluation are described below.

MODELING METHODS

Re-evaluation of Previous Model Predictions

The results of the previous model are presented in terms of dilution (or concentration) of fish processing waste versus distance from the initial dump site. Based on the results of the bioassay tests, the distance from the dump site where the effluent is diluted to the limiting permissible concentration (LPC) level can be determined.

The previous model provided results parametricly with assumed ocean current speed, pumping rate, settling velocity, and other variables. The re-evaluation will examine the range of ambient receiving water conditions, pumping rates, and effluent characteristics for the new bioassay results to determine worst case conditions.

Appropriate changes in model input parameters, such as vessel beam, vessel speed, or pumping rate, will be incorporated but the model formulation will remain as originally developed. A verification run using identical input for a previous model run will be done to confirm the same formulation is being used. A discussion of any differences between previous predictions and those for the new bioassay test results and compliance with permit conditions will be developed from the results of this phase of the model re-evaluation.

Re-evaluation of Model Assumptions and Input

The model assumptions and input can be considered in three categories:

- Model formulation assumptions: assumptions involved in the basic formulation of the model involving the fundamental physics and mathematics used

- Model development assumptions and input: the assumptions and methodology used to chose the magnitudes of the variables describing the important physical processes

- Model execution assumptions and input: the values used for the description of ambient conditions and characteristics of the waste material.

Each of these categories of model assumptions and input will be examined and re-evaluated. Each of the categories of assumptions and input is discussed in more detail below. In addition to the direct re-evaluation of the model assumptions and inputs, the sensitivity of the model will to important variables will be assessed. The results of the model predictions, and the conclusions drawn from the previous model results (for previous bioassay tests and the new bioassay tests) will be examined and discussed in terms of model assumptions and inputs. Evaluations of the degree of conservatism in the previous model formulation and execution will be presented.

Model Formulation Assumptions. The previous model formulation was based on the approach presented by Brooks (1960), and is essentially the same basic model as CDIFF (Yearsley, 1989). The formulation developed by Brooks calculates the lateral diffusion of a discharge plume as it is advected in the longitudinal direction and does not account for longitudinal dispersion.

As initially developed by Brooks, the approach does not account for vertical diffusion, does not provide for the settlement of negatively buoyant constituents in the plume, and does not account for the dispersion of a positively buoyant plume or positively buoyant components of the discharged material. In addition the model, as implemented in the FEIS, assumes a line source of constant source strength and does not simulate the discharge from a vessel traveling in an arbitrary path for a finite length of time.

The FEIS model provides for a settling velocity by redefining the longitudinal coordinate at a downward angle defined by the relationship between the longitudinal current speed and assumed vertical settling velocity such that:

$$x' = x \cdot \cos(\theta)$$

where

$\theta = \tan(u/w_s)$

u = ambient horizontal, longitudinal velocity

w_s = settling velocity

The FEIS model also accounts for vertical diffusion by applying a concentration reduction factor based on a Fickian diffusion coefficient (K_v). This factor is applied to the calculated centerline concentration (C_{max}) by

$$C_{max} \cdot \{(H/4) \cdot (2 \cdot K_v \cdot t + H^2/16)^{-0.5}\}$$

to calculate an adjusted value of C_{max} accounting for vertical diffusion, where H is the initial vertical plume dimension and t is travel time along the plume trajectory.

Each of the basic assumptions of the model and the modifications made for the FEIS model, as discussed above, will be evaluated. In particular the assumption of a continuous line source will be examined and the implications of applying the model to a source discharge of a finite time interval will be evaluated.

Model Development Assumptions. The values chosen to describe the physical processes will be evaluated. These values include the lateral and vertical diffusion coefficients. In addition the model formulation assumptions include the spatial and temporal scales over which the model predictions are used.

Model Execution Input Variables. The previous model input variables, not discussed in the model assumptions section above, include ambient current speed, initial dilution, settling velocity, and initial plume dimensions. An evaluation of the methodology and assumptions used to select the values used for these variables will be done. Changes in the values due to changes in vessel and operational procedures will be addressed. This evaluation will be extended by the sensitivity study descried below.

Model Sensitivity. The sensitivity of the model to each of input variables and to assumptions about the parameters used to describe the physical processes will be evaluated. This will be done by running the model for a range of values.

Development of Independent Model

An independent model will be developed and used to evaluate the dispersion of waste discharged from the barge. The purpose of this model is to provide a more sophisticated alternative to more realistically describe the fate and transport of the discharge. The model will, at a minimum, include the effects of diffusion in both horizontal directions (longitudinal and lateral) and will model a discharge of finite time. In addition the model will account for the spatial pattern of the discharge.

The model will use initial dilutions as determined from the size of the propeller slipstream. Vertical diffusion will be accounted for using a technique similar to that used in the FEIS model. It is anticipated that the major difference in the model predictions will be reflected in the degree of conservatism involved in the model formulations and development. Any differences in model inputs and predictions will be justified and explained.

QUALITY CONTROL AND QUALITY ASSURANCE

The objective of the quality control and quality assurance (QA/QC) effort is to provide a high level of confidence that the models are providing physically realistic predictions. QA/QC will be achieved through use of the proven models executed by staff familiar with those models. Specific QA/QC measures include: validation of model code and that the models are providing physically realistic predictions, addressing a range of potential conditions where appropriate, sensitivity analyses, and documentation and maintenance of input and output files generated during modeling activities.
The models employed in the study are mathematical representations of physical processes. The mathematical equations used are solved numerically (approximate solutions) using a digital computer. It is important that this process, which is considerably removed from the actual physical processes and behavior of the ocean, accurately simulate what happens in the ocean. The process of validation uses representative parameters for simplified system configurations to determine if the predictions reflect reality. The process of validation begins as the initial model computer code is written and continues as long as the model code is used. It is particularly important that any changes in model code be checked for validity. The final element of validation is a determination of how sensitive a model is to changes in input parameters. An extremely sensitive model probably does not provide results with a high confidence level. Sensitivity checks will be carried out for each of the models for potentially critical parameters.

Most numerical models of the type used here contain coefficients (e.g. friction factors, diffusion coefficients) that are often study site specific. Although there are generally accepted values for these coefficients, the range observed in nature is high and the models can be somewhat sensitive to the values selected. The process of calibration and verification uses measured values of forcing functions and responses to determine the appropriate coefficients for the model configuration at the study site. Typically a set of field data is used to determine the correct values to use for the coefficients. However, this is beyond the scope of the present study and there is little or no available and appropriate data for this task. In this case the model sensitivity studies, the use and justification of reasonable values for the literature and similar studies, and the incorporation of a prudent level of conservatism is required.

DATA ANALYSIS AND REPORTING

A report documenting the results of all analyses will be prepared. The report will include summaries of all input data, modeling procedures, and model results. All pertinent model results and output files (as appropriate) will be reproduced as an appendix to the report. Model results will be presented both in tabular form and graphically (i.e. contour plots) as appropriate. The report will include: an executive summary; an introduction describing the background, rationale, and general approach of the study; a description of the methods used including model formulation and input data; a description of the model results; an evaluation of the model validity for predicting dilution and plume characteristics; and, an evaluation of the concentration of the fish processing wastes within and at the boundary of the permitted ocean dumping site.

REFERENCES

Brooks, N.H., 1960. "Diffusion of Sewage Effluent in an Ocean Current," Proceedings of the First Conference on Waste Disposal in Marine Environment, Pergamon Press, NY.

SOS Environmental and Environmental & Ocean Technology, 1990. "Mathematical/Computer Modeling of Fish Waste Disposal at an Ocean Disposal Site off Tutuila Island, American Samoa". Report prepared for StarKist Seafood and Van Camp Seafood

Soule, D.F. and M. Oguri, 1983. "A report on Ocean Disposal of Fish Processing Wastes off Pago Pago , American Samoa. Report to EPA and NOAA for StarKist Foods and Van Camp Seafood. Los Angeles, California

U.S. Environmental Protection Agency, 1989. Final Environmental Impact Statement for the Designation of an Ocean Disposal Site off Tutuila Island, American Samoa for Fish Processing Waste. EPA Region 9, San Francisco, CA.

Yearsley, J.R., 1989. "Diffusion in Near-shore and Riverine Environments," EPA 910/9-87-168. EPA Region 10, Seattle, Washington.

APPENDIX 1
SPECIAL CONDITION 3.3.5

3.3.5. Eighteen months from the effective date of this special permit, the permittee shall submit a report to EPA and ASEPA on the results of suspended phase bioassay tests and reevaluation of the model used to predict the concentrations of fish processing wastes disposed at the designated site. The suspended phase bioassays shall be conducted using at least one species from each of the following three groups: Group 1 = *Mytilus* sp. (mussel), *Crassostrea* sp. (oyster), *Acartia tonsa* (copepod), or *Trypneustes* sp. (sea urchin) larvae; Group 2 = *Holmesimysis costata* (mysid shrimp) or *Penaeus vannamei* (white shrimp); and Group 3 = *Citharicthys stigmaeus* (speckled sanddab) or *Coryphaena hippurus* (dolphinfish) juveniles.

Appropriate suspended phase bioassay protocols, either protocols approved by EPA or protocols published by the American Society for Testing and Materials (ASTM), shall be followed. Suspended particulate phase bioassays shall be run using the following fish processing waste concentrations: 100%, 75%, 50%, 25%, 10%, 5%, and a control (0%). A minimum of five replicates are required per dilution concentration. Concurrent reference toxicant tests shall be conducted when the suspended phase bioassays are run.

A sampling and testing plan shall be submitted to EPA Region IX and ASEPA by October 1, 1993 for approval before the bioassay tests are conducted. Samples for the suspended particulate phase bioassays shall be composited from the permittee's onshore storage tanks. Three samples shall be taken from the onshore storage tank transfer line at 10 minute intervals. These samples shall be composited to produce one sample for analysis. The permittee's samples shall not be combined with fish processing waste from any other permittee. The permittee shall take samples on the following dates: November 30, 1993, February 28, 1994 and May 31, 1994. Samples shall be collected and shipped to the testing laboratory according to EPA-approved methods to ensure that the samples do not change before the bioassay tests begin. All suspended particulate phase bioassays shall be started within 10 days of sampling.

The testing plan submitted by October 1, 1993 should also include a proposal to reevaluate the disposal site model using results obtained from the new series of suspended phase bioassays. These bioassays are being required to confirm the toxicity of the fish processing wastes and to reevaluate the disposal operations based on the use of a different disposal vessel.

The bioassay and computer model confirmation report shall contain the following information:

3.3.5.1. INTRODUCTION AND PROJECT DESCRIPTION

The project description should include the following information about fish processing waste toxicity, previous bioassay test results, previous modelling at the ocean disposal site, and the design of the new bioassay tests.

3.3.5.2. MATERIALS AND METHODS

Fish processing waste sampling and sample handling procedures should be described or referenced.

References for laboratory protocols for suspended phase bioassay tests.

1) EPA-approved methods and references.

2) Test species used in each test, the supplier or collection site for each test species, and QA/QC procedures for maintaining the test species.

3) Source of seawater used in reference, control and bioassay tests.

4) Data and statistical analysis procedures.

5) Limiting Permissible Concentration (LPC) calculations.

6) Description of model selected to evaluate dispersal of fish processing wastes at the ocean disposal site. Use of this model shall be approved by EPA Region IX and ASEPA before it is used by the permittee to evaluate the fish processing waste disposal plume.

3.3.5.3. DESCRIPTION OF SAMPLING PROCEDURES

QA/QC procedures and actual sampling procedures used during fish processing waste stream sampling and handling of the samples.

3.3.5.4. FINAL RESULTS, ANALYSIS OF DATA AND DISCUSSION

1) Complete bioassay data tables and summary bioassay tables shall be furnished in the report. All data tables should be typed or produced as a computer printout.

2) The permittee shall analyze the bioassay data and calculate the LPC of the material as defined at 40 C.F.R. § 227.27(a-b).

3) The permittee shall use the LPC in the approved plume model to determine the concentration of fish processing wastes disposed at the designated ocean disposal site which complies with EPA's Ocean Dumping Criteria defined at 40 C.F.R. Parts 227 and 228.

3.3.5.5. REFERENCES

This list should include all references used in the field sampling program, laboratory protocols, LPC calculations, modelling analyses, and historical data used to evaluate the fish processing waste disposal operations at the designated ocean disposal site.

3.3.5.6. DETAILED QA/QC PLANS AND INFORMATION

The following topics should be addressed in the QA Plan:

1) QA objectives.

2) Organization, responsibilities and personnel qualifications, internal quality control checks.

3) Sampling and analytical procedures.

4) Equipment calibration and maintenance.

5) Sample custody and tracking.

6) documentation, data reduction, and reporting.

7) Data validation.

8) Performance and systems audits.

9) Corrective action.

10) Reports.

APPENDIX 2
PRELIMINARY IDOD OBSERVATIONS

(THIS SECTION TO BE
ADDED AND FAXED
TO YOU 11/15/93

APPENDIX 3
LABORATORY QUALIFICATIONS AND QA/QC PROCEDURES

INTRODUCTION

Advanced Biological Testing Inc. (ABT) is a scientific consulting firm providing environmental and aquatic toxicological services to public and private clients. Established in 1993, ABT has a professional and technical staff of the highest caliber. The organizational, professional and performance history of our personnel attests to our commitment to focusing on the clients' particular requirements or problems.

ABT is a California corporation with laboratory and offices in Tiburon, California. It is a small, woman-owned business. ABT scientists have been involved in a wide variety of long-term projects, including the development of effluent characterization programs and the design and implementation of these programs. They have also participated in test protocol development programs for marine and freshwater toxicity testing. ABT personnel have conducted marine environment mitigation assessment studies; bay, harbor and marina activity impact analyses; and a wide variety of aquatic toxicological studies. Specific projects have assessed the effects of dredged material toxicity and disposal; assessment of toxicity from ocean and bay wastewater outfalls; drilling fluid toxicity testing and dispersant bioassays for the offshore oil and gas industry, and toxicity identification evaluations.

Our personnel have extensive experience in sampling in the marine environment; taxonomic analysis of marine communities; sediment characterization and toxicity assessment; and laboratory and field aquatic toxicity testing.

ABT provides a full-service aquatic toxicology laboratory with marine and freshwater test systems that can be modified on short notice for specialized and large-scale tests. The testing laboratory is fully equipped to conduct the entire range of freshwater and marine toxicity tests, including flow-through, static and static-renewal studies. Our personnel are knowledgeable in organizing, interpreting, and presenting large data sets as well as having thorough knowledge of data quality assurance, and analytical interpretation. Reports developed out of these efficient data analyses are of the highest professional quality and are delivered to the client in a timely manner.

ORGANIZATION AND QUALIFICATIONS

ORGANIZATION

Advanced Biological Testing Inc. (ABT) is a woman-owned business under the general management of Ms. Sandi Kline. The Technical Director and President is Dr. Kurt Kline, and the Project Manager is Mr. Mark Fisler. It is currently registering as a woman-owned business with the State of California.

QUALIFICATIONS

Ms. Sandra Kline: Ms. Kline is Executive Officer and General Manager of ABT. She has over twelve years experience in business including scientific consulting and commercial insurance. She manages the day to day operations of ABT including the management of subcontractors, in-house accounting, and contract management. In consultation with Dr. Kline and Mr. Fisler, she prepares bids as well as qualifications statements. She supervises the production of all technical reports for the company. She is a member of the Society of Quality Assurance and also acts as the QA supervisor for the testing carried out at the laboratory. She has taken and passed the EPA Society of Quality Assurance course.

Dr. Kurt F. Kline: Dr. Kline is President of ABT He received his doctoral degree from the University of California at Davis in Ecology in 1978, with a specialization in aquatic ecology, bio-statistics and fisheries biology. Dr. Kline has over twenty years of experience in the environmental consulting field, with the last ten years in aquatic toxicology and laboratory management. He has experience in all phases of aquatic bioassay testing, with specific expertise in sediment toxicity studies, including dredge material analyses. He is an active member of the American Society of Testing and Materials (ASTM) Committee E-47 as well as the Society of Environmental Testing and Analytical Chemistry (SETAC). He presents scientific papers at meetings and symposia annually.

Mr. Mark W. Fisler: Mr. Fisler is the Vice-President of ABT and serves as the Project Manager for the laboratory. He has been conducting marine biological research for eight years. He received his B.S. degree in Biology from George Mason University in 1984. As a Project Manager, Mr. Fisler has performed a variety of aquatic studies including numerous dredge bioassays. Mr. Fisler is responsible for field collection of sediments and water samples, and is experienced with a variety of collection apparatus.

QUALITY ASSURANCE PROGRAM

Quality assurance in all phases of the testing programs is an important function at ABT. Our goal is to generate irrefutable results for all of our clients, and the QA/QC program in place at our laboratory provides the documentation necessary to assure our clients that the data presented to them is of the highest quality. The QA/QC program extends from sample receipt to testing to statistical analysis of the data to the ultimate presentation of the final report.

- **Staff Responsibilities for Quality Assurance**
- **Sample Custody**
- **Quality Assurance Objectives**

STAFF RESPONSIBILITIES FOR QUALITY ASSURANCE

The responsibility for specific project management is established to maintain project timelines, efficient and cost effective testing, and report preparation. It defines the lines of authority and provides the client with the individual(s) responsible for their testing program. The following information provides the client with the duties and responsibilities for each key individual.

Technical Director

The Technical Director will represent management and will:

- Be the initial point of contact for the client.
- Assure that all necessary resources are available.
- Assure that the Quality Assurance Unit is fully informed and involved in the project.
- Assure that all personnel are informed of project QA policy.
- Review all communication from the QA regarding the project.
- Assure that any problems, deviations, etc., reported by QA receive immediate corrective action.
- Review and approve any QA plan.
- Be responsible for the preparation of the final report.

QA Unit

The QA Unit (QA) will be responsible to the Technical Director and will:

- Supervise audits and submit a summary audit report to the Project Manager.
- Assist in the preparation of any required project QA plan.
- Communicate closely with the Project Manager.
- Inform Project Manager and Technical Director of any problems and corrective action.
- Review data files, records, forms or any other hard copy information.
- Determine that analyses and procedures were done according to protocols.
- Document any deviations from standard procedures.

Project Manager

The Project Manager will be responsible for performing the toxicity tests and will:

- Be responsible for training of staff where required.
- Be responsible for sample custody and initial water quality analysis.
- Take corrective action for any problems observed and documented by QA.
- Maintain control of data files, notes, records and other hard copy information.
- Be responsible for sample and data traceability.

- Enforce protocol requirements.
- Help prepare the project QA plan.
- Ensure that QA receives sufficient documentation to determine that the project QA requirements have been satisfied.
- Analyze data collected for QA (external analyses, etc.) for inclusion in final report.

SAMPLE CUSTODY

All samples are maintained under chain-of-custody, which documents the acquisition, storage and testing of any sample received by the laboratory. This procedure provides the client with the highest level of security during the sampling, transportation and testing of their materials.

Sample chain-of-custody (C-O-C) sheets will be prepared by the individuals collecting the samples for those samples shipped from field test sites to ABT for testing. In the event that a chain-of-custody form is not provided to the laboratory, one will be initiated at the time the sample is delivered to the laboratory by the sample custodian. These C-O-C sheets will include the sample ID number, date and time of sampling, volume of sample, preservatives added (if any) and the analyses or tests to be performed. A brief description of each sample will also be included. The sheets will also include the identity of the person packaging the samples, the transportation method used and date of shipment. The original sheet will accompany the samples being shipped.

QUALITY ASSURANCE OBJECTIVES

Quality assurance procedures to be used for sediment testing are consistent with methods described in the U.S.EPA/ACOE (1991) and U.S.EPA (1985 a, b). The methods employed in every phase of this sediment testing program are detailed in standard protocols and procedures maintained in the bioassay laboratory.

The quality assurance objectives for toxicity testing conducted by ABT involve all aspects of the testing process including: (1) water and sediment sampling and handling; (2) source and condition of test organisms; (3) condition of equipment; (4) maintenance of appropriate testing conditions; (5) instrument calibration; (6) use of reference toxicants; (7) record keeping; and (8) data evaluation.

<u>Water and sediment sampling and holding</u>: Sediment samples will be maintained at 4°C in the dark until they are used in the testing system. All sediments will be held in sealed storage bags. Water and Effluent samples will be maintained for no more than 36 hours as specified by EPA procedures.

<u>Source and condition of test organism</u>: All test organisms will be purchased from reputable suppliers who have provided ABT with organisms in the past. Normally, all test organisms are maintained in the laboratory for acclimation (exception are bivalves and echinoderms). If mortality in excess of 5% is noted in the holding stock, the animals will be discarded and a new batch ordered.

<u>Maintenance of test conditions:</u> Each test has a set of specified test conditions as defined in the standard testing guide or protocol. The specific required parameter limits are generally noted in the section on the acceptability of the test. If these criteria are not met, the test will be rerun if appropriate.

<u>Calibration procedures and frequency:</u> Instruments are calibrated daily according to Laboratory Standard Operating Procedures (SOPs) and calibration data are logged and initialed. Calibration logs are monitored weekly to ensure that they are complete.

<u>Reference toxicant testing</u>: A reference toxicant will be run routinely during the test period to establish the validity of the toxicity data. Reference toxicant data for species used in the performance of aquatic bioassay are available at the laboratory, and the LC50 should fall within

two standard deviations of the current laboratory mean. Water quality measurements will be monitored to ensure they fall within the prescribed limits for each test procedure, and corrective actions will be taken if appropriate.

Test deviations: All deviations from the standard testing guide or procedure will be reported with the final report. If any aspect of a test parameter deviates from protocol, the test will be evaluated to determine whether its validity has been compromised according to the regulatory agency to which it will be submitted. If the study has been compromised, the client will be notified and the test rerun.

Internal quality control checks: The quality control unit conducts periodic audits to ensure that test conditions, data collection and test procedures are according to protocol. Animal receipt and maintenance log books are used to record the source and health of organisms. Reference toxicant tests act as an internal check on organisms health and performance during the test.

Sample storage and tracking: Sample chain-of-custody (C-O-C) sheets will be prepared for each of the samples shipped from the field to ABT for aquatic toxicity tests. These C-O-C sheets will include the sample ID number, date and time of sampling, volume of sample, preservatives added (if any) and the analyses or tests to be performed. A brief description of each sample will also be included. The C-O-C sheets will also include the identity of the person packaging the samples, the transportation method used and date of shipment. The original sheet will accompany the samples being shipped.

Upon receipt of any sample, laboratory personnel will enter the time and date of arrival, the identity of the carrier as well as the person receiving the samples, and the condition of the samples on the C-O-C sheet. All persons involved with sampling, transporting or receiving the sample will sign and date the C-O-C. A copy of the sheet will be returned to the client. The original C-O-C form will be kept for the study files. The samples will then enter into the laboratory sample control system to ensure proper storage (4 ± 2°C) and holding time.

Under normal circumstances all aqueous samples will be immediately analyzed for dissolved oxygen, pH, conductivity or salinity, temperature, total residual chlorine and ammonia. These data are entered into the data package. If the results of this analysis lead the laboratory to suspect testing problems, the client will be called immediately and the potential problems discussed. No testing will be carried out without this verified communication process.

Data analysis, validation and reporting: All bioassay tests are performed according to protocols and standard test conditions. The quality control unit checks all the raw data and records of the study to ensure that the required test conditions are within specifications. Any unforeseen circumstances that may affect the integrity of the study are reported with the test results. The data analysis and final report are reviewed for accuracy by QA.

Procedures used to assess data precision and accuracy: The precision of the LC50 determination from the reference toxicant will be shown by calculating the 95 percent confidence intervals and standard deviations over time. Acceptable accuracy will be a mean reference toxicant value that is within two standard deviations of the current laboratory mean. A value greater than two standard deviations but less than three could be acceptable if the results of the sediment testing indicate that no significant sensitivity (or lack of sensitivity) was apparent in the testing.

Dave Stuart
W-7-1 ✓

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 19, 1993

Steven L. Costa
Project Manager
CH2M Hill
P.O. Box 12681
Oakland, CA 94604-2681

Re: Approval of Modifications to the Joint Cannery Outfall Study Plans: Effluent Chemistry and Bioassays

Dear Steve:

We have reviewed the reports on the chemical analysis of effluent for VCS Samoa Packing (April 30, 1993) and StarKist Samoa (April 29, 1993), as well as the technical memorandum of May 10, 1993 on bioassay tests on the combined cannery effluent. Our comments on these reports and their recommendations are as follows:

Effluent Bioassay Tests

The first bioassay results indicated the effluent probably has a high immediate dissolved oxygen demand (IDOD) which was responsible for the observed mortality of the test organisms. We approve of the proposal to continue to use a combined cannery effluent sample as done in the first bioassay tests, and include immediate dissolved oxygen demand (IDOD) tests on these samples. The tests will then be run with sufficient aeration to support the test organisms. Parallel tests should also be run following standard procedures.

Reasonable attempts must be made to obtain *Penaeus vannamei* as the test organism. However, in the event these organisms are not available, *Mysidopsis bahia* and/or *Holmesimysis costata* may be used as substitute organisms.

Please see the attached memo from Amy Wagner of EPA's Laboratory Support Section for further comments on the results and proposed study plan.

Chemical Analysis of Effluent

The chemical analysis of the effluent revealed exceedances of ambient water quality standards for silver (StarKist) and copper and zinc (Samoa Packing). If the results of the second tests show similar exceedances, this will be cause for concern and we will require the canneries to seek the source of the metals and implement measures to reduce their discharge.

However, since dioxin and asbestos were not detected in the effluent, we are approving the request to eliminate analyses for these substances in future effluent chemical analyses.

Please call Pat Young at 415/744-1594 if you have any questions regarding the above.

Sincerely,

O G Heyman

for Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs (E-4)

Enclosure

cc: Jim Cox, Van Camp Seafood Company
Norman Wei, StarKist Seafood Company
Tony Tausaga, American Samoa EPA
Sheila Wiegman, American Samoa EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 1, 1993

SUBJECT: Review of Joint Cannery Outfall Effluent Bioassay Testing results

FROM: Amy L. Wagner, P-3-1 Amy
Laboratory Support Section

THRU: Brenda Bettencourt, Chief
Laboratory Support Section

TO: Pat Young, E-4
OPINAP

I have reviewed the bioassay testing report of the Joint Cannery Outfall for StarKist Samoa and VCS Samoa Packing. The comments below summarize our discussion today.

1. The report suggests (p. 4) that a high immediate dissolved oxygen demand (IDOD) may be responsible for the toxicity testing results. However, supplementary tests still showed 100% toxicity when test containers were aerated. These results suggest toxicity in the effluent was due to factors other than low dissolved oxygen concentrations. It should be noted that the chemical analyses indicated high levels of metals. Specifically, the reported values for copper and zinc exceed some acute levels for marine invertebrates in the water quality criteria documents.

2. The manual "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms," Fourth Edition, EPA/600/4-90/027, should be followed more closely in future tests. As stated in Table 15 (p. 64), aeration should be provided if dissolved oxygen falls below 4.0 mg/L and a renewal of the test solutions must be conducted after 48 hours. As proposed in the report, an IDOD test may be run on the effluent prior to testing.

3. Although testing is being conducted on a semi-annual basis, a reference toxicity test must also be run concurrently with the effluent toxicity test. Reference toxicity tests are stipulated in the acute toxicity testing manual (p.8) and provide information on the consistent quality of test organisms.

4. Use of the white shrimp, Penaeus vannamei should be continued. If this species is unavailable, Mysidopsis bahia would be an acceptable surrogate species since it is listed in EPA's acute toxicity testing methods manual to be mandated in the Federal

Register this year. Formal approval of this substitute organism is the responsibility of the Permits Issuance Section.

Further information regarding toxicity testing policy and permit language should be referred to the Whole Effluent Toxicity Coordinator, Debra Denton (W-7-1), at 744-1919. I have given her a copy of the permit and report. If you have any further questions, please do not hesitate to contact me at 744-1495.

cc: Debra Denton, W-7-1

ROUTING AND TRANSMITTAL SLIP

Date 9/15

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. Dave Stuart W-7-1		
2.		
3.		
4.		
5.		

	Action		File		Note and Return
	Approval		For Clearance		Per Conversation
	As Requested		For Correction		Prepare Reply
	Circulate		For Your Information		See Me
	Comment		Investigate		Signature
	Coordination		Justify		

REMARKS

Here's the bioassay study. I believe I passed this on to Janet some time ago w/ four other studies (effluent testing, sediment study. etc.) What do you think of their conclusions + recommendations?

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)	Room No.—Bldg.
Pat Young E-4	Phone No.

5041-102

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

★ U.S. GPO: 1988 — 241-174

I gave copy to Lab Svcs Section see what they thought

MAY 17 1993 SM

CH2M HILL
Engineers
Planners
Economists
Scientists

10 May 1993

PDX30702.EL

Patricia N.N. Young
American Samoa Program Manager
Office of Pacific Islands and Native American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street (E-4)
San Francisco, California 94105

Dear Pat:

Subject: Joint Cannery Outfall Effluent Bioassay Testing

Enclosed are two copies of a Technical Memorandum describing the results of the bioassay testing done under StarKist Samoa and VCS Samoa Packing NPDES permit requirements.

If have any questions please feel free to call me at your convenience.

Sincerely,

CH2M HILL

Steven L. Costa
Project Manager

cc: Norman Wei, StarKist Seafood Company
James Cox, Van Camp Seafood Company
Maurice Callaghan, StarKist Samoa, Inc.
Michael Macready, VCS Samoa Packing Company

CH2M HILL
1111 Broadway, Suite 1200, Oakland, CA 94607-4046
P.O. Box 12681, Oakland, CA 94604-2681
510 251-2426
Fax No. 510 893-8205

PREPARED FOR:	StarKist Samoa, Inc. VCS Samoa Packing Company
PREPARED BY:	Steve Costa/CH2M HILL/SFO David Wilson/CH2M HILL/SEA Tim Hamaker/CH2M HILL/RDD
DATE:	10 May 1993
SUBJECT:	**Bioassay Testing of Effluent February 1993 Sampling**
PROJECT:	PDX30702.EL.R1

Purpose

This memorandum presents the results of the effluent bioassay testing of the Joint Cannery Outfall effluent sample that was collected in February 1993. This is the first of the required semi-annual tests. Previous Technical Memoranda described the results of concurrent effluent chemistry testing.

Study Objectives

Section D.1 of the StarKist Samoa and VCS Samoa Packing NPDES permits requires that semi-annual definitive acute bioassays (96-hour, static bioassays) be conducted on the cannery effluent. The purpose of these bioassays is to determine whether, and at what effluent concentration, acute toxicity may be detected for the effluent.

These bioassays are to be conducted using the white shrimp, *Penaeus vannamei* (postlarvae). The acute biomonitoring effluent sampling must be concurrent with effluent sampling for priority pollutant chemical analysis. Effluent samples are to be collected as 24-hour composite samples.

The first semi-annual effluent acute bioassay was conducted using a composite effluent from both the StarKist Samoa and VCS Samoa Packing facilities, as approved by EPA. This combined effluent bioassay is representative of the wastewater discharged from the Joint Cannery Outfall.

Effluent Sampling Methods

Between 0900 on February 16th and 0900 on February 17th, 1993, a 24-hour, flow-weighted composite sample of final effluent was collected from both the StarKist Samoa and VCS Samoa Packing treatment plant discharges. Samples were collected from the established effluent sampling sites following the routine composite sample collection schedule for the plants.

A total of eight grab samples were collected into pre-cleaned 5-gallon plastic cubitainers at each plant. Samples were collected at three-hour intervals over a 24 hour period. The samples were stored on ice until the completion of the 24-hour sampling period. After all samples were collected a flow-proportioned composite sample was prepared. The grab sample collection times and the relative effluent volumes calculated from plant flow records are summarized in Table 1. The relative effluent volumes were used to prepare the final composite sample, which was used to fill the sample containers shipped to the laboratory for testing.

Table 1
StarKist Samoa and VCS Samoa Packing 24-hour Composite Sample for Bioassay Testing
February 16-17, 1993

Grab Sample Number	VCS Samoa Packing		StarKist Samoa		VCS Samoa Packing Percent of Total Flow	StarKist Samoa Percent of Total Flow
	Sampling Time	Effluent Flow Rate (gpm)	Sampling Time	Effluent Flow Rate (gpm)		
1	1200	540	1100	950	36	64
2	1500	540	1400	800	40	60
3	1800	540	1700	800	40	60
4	2200	550	2000	800	41	59
5	2400	560	2300	800	41	59
6	0300	680	0200	850	44	56
7	0600	640	0500	850	43	57
8	0900	620	0800	825	43	57
Mean		584		834	41	59

Sample cubitainers were packed on ice in ice chests for shipment to the laboratory. Sample chain of custody forms were completed and then sealed into zip-lock bags and taped inside the lid of the ice chest. Samples were shipped as checked luggage on flights from Pago Pago to Honolulu and then to San Francisco. Samples that were composited on February 17th, were delivered to the testing laboratory at 0930 on February 19th. Laboratory bioassay test reports and chain-of-custody forms are attached to this memorandum. The chain of custody forms are included in Attachment I and the laboratory test report is included as Attachment II.

Results

The bioassay tests were conducted by MEC Analytical Systems, Inc., Tiburon, California. The results were provided by the laboratory in the *Summary Report for an Acute Bioassay Conducted under NPDES* dated March 18, 1993 included as Attachment II. This report summarizes the 96-hour acute bioassay test conducted with reference to the EPA document *EPA/600/4-90/027* as the source of methods for conducting the test.

The results of the bioassay tests (LC50 = 4.8-percent effluent; NOEC = 3.13-percent effluent) indicate that: [1] whole effluent at high concentrations may be toxic under laboratory conditions or, [2] the standard bioassay laboratory test procedures may not be appropriate for this type of effluent. Based on the test data the latter appears to be the more likely. Neither of these possibilities should be of concern. The consequences of both possible interpretations are as follows:

[1] The maximum whole effluent toxicity potentially indicated by the laboratory tests (but not confirmed) would require a dilution of about 32:1 (3-percent effluent concentration) to achieve non-toxic levels after one to three days of exposure. Under actual field conditions in Pago Pago Harbor the initial dilutions, under worst case conditions, are predicted to be about 350:1 (0.29-percent effluent concentration) which is achieved in less than two minutes. This is over ten times the 32:1 level indicated above. <u>Therefore, under actual field conditions, organisms will not be exposed to effluent at potentially toxic levels present under laboratory conditions..</u>

The indicated 32:1 level represents a toxicity mixing zone considerably smaller than that already provided in the NPDES permits for ammonia. For example, using the results of the modeling previously done for the mixing zone application, assuming worst case conditions, a dilution of 32:1 is predicted within 12 seconds of discharge and within 6½ meters of the diffuser ports. Given the depth of discharge (about 180 feet) and the high discharge jet velocity, it is unlikely that any organism could be exposed to effluent at less than 32:1 for more than a few seconds.

[2] The effluent probably has a high immediate dissolved oxygen demand (IDOD) which may be responsible for the observed bioassay results. The low dissolved oxygen (DO) measured after 24 hours during the laboratory tests would account for observed mortality (see test results in Attachment II). Supplementary tests, as described in the test results, did not include measurements to investigate short term IDOD effects. To determine the influence of IDOD, it is recommended below that the laboratory procedure be modified to remove the IDOD from the effluent sample prior to bioassay testing.

Under actual discharge conditions initial mixing is much more rapid (seconds) than IDOD effects (minutes to hours) and no measurable DO sag due to IDOD would be observed. <u>Therefore, mortality of test organisms attributable to IDOD effects is an artificial laboratory testing effect that would not be observed under actual discharge conditions.</u>

Discussion

The survival data from this test are relatively self explanatory. In laboratory tests the effluent appears to produce mortality in the test organism at concentrations of approximately 3- to 6-percent after 24 hours of exposure. The 96-hour LC50 value was determined to be 4.8-percent effluent (±0.5-percent effluent at 95-percent confidence limits). The NOEC value was determined to be 3.13-percent effluent. The cause of the mortality is uncertain. High un-ionized ammonia, a pronounced dissolved oxygen sag over the first day of the test, a high immediate dissolved oxygen demand (IDOD), and low pH all could potentially have contributed to observed laboratory test results. The following analyses were conducted to examine each of these factors:

- **Ammonia.** Un-ionized ammonia was calculated to be 0.215 mg/l in 100-percent effluent and 0.021 mg/l in 6.25-percent effluent. No available data was found for ammonia toxicity to *Penaeus vannamei.* For other shrimp species LC50 values for un-ionized ammonia vary widely from 0.23 to 3.41 mg/l. Such data suggest that constituents or conditions other than or in addition to ammonia are involved in producing the observed test results.

- **BOD.** The high BOD levels of the effluent resulted in a significant and potentially lethal DO sag over the first 24 hours of the test (aeration was used throughout the remainder of the test and no additional mortality was observed). The laboratory ran additional tests to determine if low dissolved oxygen was responsible for the observed test results. Extra sample was used to prepare 25- and 50-percent concentrations that were aerated. After 24 hours 100-percent mortality had occurred, although DO levels at the end of the test were high enough to prevent mortality. This could be interpreted to indicate that mortality did not solely result from low DO levels over the first 24 hours. However, the tests were not continuously monitored for DO. Therefore a rapid, immediate, and lethal DO sag with subsequent recovery to nonlethal DO levels (as described below) would not have been detected.

- **IDOD.** The supplementary tests, described above, may not have identified effects of high IDOD in the effluent. The effluent may exhibit a rapid DO demand within a time scale of minutes to hours. This could result in a transient lethal DO level that would not be detected under standard laboratory monitoring procedures. After an initial DO sag, subsequent continuous aeration would elevate DO to acceptable and non-lethal concentrations. Mortality could be induced by the IDOD induced transient DO sag. IDOD measurements and modified bioassay procedures are recommended for the next test period to resolve this issue.

- **pH.** Many species of shrimp have relatively narrow tolerances to changes in pH. Natural seawater has a pH range of approximately 7.9-8.3. Initial pH values during the test were somewhat lower than the natural values, but probably still within the tolerance range for *Penaeus vannamei.* For the initial test solution, pH varied with increased effluent concentration, decreasing from pH 7.63 in the 1.56-percent effluent (and the control group), to pH 7.06 in the 50-percent effluent. An initial pH of 7.33 was measured in 100-percent effluent. Mortalities of 10- and 100-percent were observed for concentrations of 3.13- and 6.25-percent effluent, respectively. Corresponding initial pH values were 7.67 and 7.5, respectively. After 24 hours corresponding pH values were 7.55 and 7.26, respectively. This is a narrow range of pH values, within the expected tolerance range of the organism, and it is unlikely that pH is solely responsible for the bioassay test results observed.

The mortality dose response curve for this effluent was very steep in this bioassay test. This result indicates that a threshold (of effluent concentration) was reached beyond which mortality occurred. The cause of laboratory test results is not known, but high IDOD is suspected as the primary cause. It is important to recognize that the potential exposure time of organisms to actual discharged effluent in the harbor is extremely limited. A 3.13-percent effluent concentration (the NOEC) is equivalent to a dilution of 32:1. The modeling done for the mixing zone application indicates that, for worst case conditions, a 32:1 dilution is reached within 12 seconds of discharge from the diffuser within a distance of about 6½ meters from the discharge port. This rapid mixing would entirely eliminate the effects of high IDOD or any potentially toxic constituent.

Conclusions and Recommendations

The laboratory test results for the Joint Cannery Outfall effluent are not of concern. Ammonia effluent limitations are incorporated into the NPDES permit. For example, the ammonia limits were based on a toxicity mixing zone represented by an initial dilution of 80:1. Therefore, existing effluent limitations and permit conditions exceed those required to account for the laboratory bioassay test results for the effluent.

The laboratory conducting the tests was selected based on an evaluation by CH2M HILL of a list of five candidate laboratories. The tests were conducted in a thorough manner and the results appear valid and scientifically sound. Laboratory staff have suggested that aeration be started immediately on subsequent tests. Since the test species is not a standard bioassay species reference toxicant quality control charts have not been developed. For the limited testing to be conducted (once every 6 months) the development of reference toxicant information is not recommended.

The observed bioassay results may have been induced in the laboratory by high IDOD levels. CH2M HILL recommends that IDOD be measured in the effluent prior to the next bioassay test. If the IDOD measurements indicate a potential cause of mortality, the bioassay test procedure should be modified to eliminate IDOD prior to testing. The proposed modified procedure will be made available for review by USEPA and ASEPA. Parallel tests would be run following standard procedures.

Difficulty was found in obtaining the organisms for the test. The organism is a common aquiculture species but not a standard bioassay species. Therefore, the postlarval life stage is not always available and is difficult to obtain in small quantities. This results in a relatively expensive test organism that may not be available at the time scheduled for future testing. CH2M HILL strongly recommends that an alternate organism be selected and approved by the U.S. Environmental Protection Agency and the American Samoa Environmental Protection Agency prior to the next scheduled test in August 1993.

ATTACHMENT I

CHAIN OF CUSTODY FORMS

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 16 and 17, 1993

STARKIST SAMOA, INC. and VCS SAMOA PACKING COMPANY

CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #:
Purchase Order #:

Project Name: Starkist / Samoa NPDES

Company Name/CH2M HILL Office: CH2M-Hill - Seattle / SFO

Project Manager & Phone # Mr. [ ] Ms. [ ] Dr. [ ]: David Wilson

Report Copy to: Steve Costa

Requested Completion Date:

Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER ____

Sample Disposal: Dispose [ ] Return [ ]

LAB TEST CODES

ANALYSES REQUESTED: Bioassay Shrimp

SHADED AREA – FOR LAB USE ONLY: Lab 1 # | Lab 2 # | Quote # | Kit Request # | Project # | No. of Samples | Page | of | COC Rev | Login | LIMS Ver | Ack Gen

93 Sampling Date	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	Bioassay Shrimp	REMARKS	LAB 1 ID	LAB 2 ID
2/17	12:00	X		X		STARKIST	1	X	1 ~5gal Cubitainer on ice		

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
[signature]	2/17/93 1300	[signature]	2/17/93

Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
[signature] Don Kingery	2/17/93 1445	[signature]	2/19/93 9:31

Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name)	Date/Time
[signature] / MEC TAYLOR(?)	2/19/93 0930		

Received By (Please sign and print name)	Date/Time	Shipped Via	Shipping #
		UPS BUS Fed-Ex Hand Other____	

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other: ____
COC Rec | ICE
Ana Req | TEMP
Cust Seal | Ph

Work Authorized By (Please sign and print name):

Remarks: Composite both 5gal cubitainers together

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client
REV 11/92 FORM 340

CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #	Purchase Order #
Project Name: StarKist/Samoa NPDES	
Company Name/CH2M HILL Office: CH2M-Hill-Seattle	
Project Manager & Phone #: Mr. [ ] Ms. [ ] Dr. [ ] David Wilson	Report Copy to:
Requested Completion Date:	Sampling Requirements: SDWA [ ] NPDES [X] RCRA [ ] OTHER ___
Sample Disposal: Dispose [ ] Return [ ]	

LAB TEST CODES

ANALYSES REQUESTED: Bioassay

SHADED AREA -- FOR LAB USE ONLY: Lab 1 # / Lab 2 # / Quote # / Kit Request # / Project # / No. of Samples / Page of / COC Rev / Login / LIMS Ver / Ack Gen

Sampling Date ('93)	Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	Bioassay	REMARKS	LAB 1 ID	LAB 2 ID
2/17	12:00	X		X		STARKIST	2	X	2-5gal cubitainer on ice		

Sampled By & Title (Please sign and print name): [signature]	Date/Time: 2/17/93 1300	Relinquished By (Please sign and print name): [signature]	Date/Time: 2/17/93 1650
Received By (Please sign and print name): [signature] Don Kingery	Date/Time: 2/17/93 1650	Relinquished By (Please sign and print name): Donald Kingery	Date/Time: 2/19/93 9:30
Received By (Please sign and print name): [signature] PETARGART	Date/Time: 2/19/93 0930	Relinquished By (Please sign and print name):	Date/Time:
Received By (Please sign and print name):	Date/Time:	Shipped Via: UPS BUS Fed-Ex Hand Other___	Shipping #:
Work Authorized By (Please sign and print name):	Remarks: Samples are 24 hour composites started 2/16/93 @ 1100		

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other:
COC Rec / ICE
Ana Req / TEMP
Cust Seal / Ph

Instructions and Agreement Provisions on Reverse Side

* Composite both containers together for Bioassay sample - see 2nd cooler.

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client
REV 11/92 FORM 340

ATTACHMENT II

LABORATORY REPORT
MEC Analytical Systems, Inc
96-hour Acute Bioassay

JOINT CANNERY OUTFALL EFFLUENT SAMPLES
February 16 and 17, 1993

STARKIST SAMOA INC. and VCS SAMOA PACKING COMPANY

SUMMARY REPORT FOR AN ACUTE BIOASSAY CONDUCTED UNDER NPDES

MEC Analytical Systems, Inc.
Bioassay Division
98 Main St #428
Tiburon, CA 94920

Client: CH2M Hill California, Inc.
1111 Broadway
Oakland, CA 94607

REPORT DATE: March 18,1993

SAMPLE AND BIOASSAY INFORMATION

PROJECT # 93014-1

TEST INFORMATION

Type: 96-Hour Acute
Concentrations (%): 1.56, 3.13, 6.25, 12.5, 25, 50, 100

Species: *Penaeus vannamei*
Common name: White Shrimp
Age: post - larval
Mean length (mm): 7.6
Mean weight (mg): 0.66

TEST PARAMETERS

 # Organisms/tank: 10
Source: Brezina & Associates
Dillon Beach, CA

Exposure volume (mL): 500
Test chamber size (mL): 1000

SAMPLE INFORMATION

Project Name: Starkist/Samoa NPDES
Sample ID: Starkist, 24 hour composite
Date Sampled: 2/16/93-2/17/93
Sample Received: 2/19/93
Test Start Date: 2/20/93
Sample Preparation: Salinity to 25ppt
Diluent: Ocean Beach Seawater at 25ppt

COMMENTS:
Ammonia levels in the effluent were very high. Un-ionized ammonia levels reached 0.215 mg/L in 100% effluent. Mortality occurred in all concentrations down to 6.25%, which had an un-ionized ammonia of 0.021 mg/L. Data for ammonia toxicity to Penaeus vannamei was unavailable, but data for other shrimp species indicate widely varying LC50s (from 0.23 to 3.41 mg/L NH_3 -N).
These data implicāte toxicant(s) other than ammonia. Dissolved oxygen levels were low throughout the test. Solutions were aerated 24-hours after the test began, but mortality occured in the first 24-hours of the study. To determine if low oxygen levels caused the mortality a mini-study was performed. Extra sample was used to prepare 25% and 50% concentrations; these soulutions were aerated, and organisms were placed in them. Dissolved oxygen levels were high enough to be non-toxic, but after 24-hours, 100% mortality occured. These data indicate toxicity was not due solely to low dissolved oxygen levels.

RESULTS	
LC50 (%):	4.8
95% CL	(4.3-5.2)
Method:	Spearman - Karber

NOEC (%):	3.13
METHOD:	Bonferroni Adjusted t- Test

Reference: EPA 1990 Methods for Measuring the acute toxicity of effluents to freshwater and marine organisms, Third edition. Peltier, W.H. and C.I. Weber eds. EPA, Enivironmental Monitoring and Support Laboratory, Cincinnati, OH, EPA/600/4-90/027.

Kurt F. Kline, Ph.D.	Laura Targgart	Eugenia McNaughton Ph.D.
Laboratory Director	Study Director	QA Manager

Project #: 93014

Water Quality Data

Sample	pH (units)	DO (mg/L)	Total NH3 (mg/L)	Total Cl2 (mg/L)	Initial Sal (ppt)
Effluent	6.47	2.5	40.6	0.05	12.6

Initial Water Quality:

Conc (%)	Rep	Day 0 °C	DO	pH	Sal	Day 1 °C	DO	pH	Sal	Day 2 °C	DO	pH	Sal	Day 3 °C	DO	pH	Sal
Control	1	20.1	9.4	7.67	25	19.7	9.3	7.67	25	19.4	8.9	7.62	25	19.1	9.0	7.58	25
Saline	1	20.3	9.6	8.10	25	19.8	9.6	8.08	25	19.6	8.9	8.10	25	19.7	9.2	8.20	25
1.56	1	20.2	9.3	7.63	25	19.4	9.3	7.68	25	19.5	8.9	7.65	25	19.8	9.2	7.77	25
3.13	1	20.1	9.4	7.67	25	20.1	9.3	7.67	25	20.5	8.9	7.65	25	19.6	9.0	7.78	25
6.25	1	20.1	9.3	7.50	25	20.3	9.2	7.67	25	20.1	8.8	7.62	25	19.6	9.0	7.63	25
12.5	1	20.2	8.8	7.38	25												
25	1	20.4	8.4	7.19	25												
50	1	20.1	7.6	7.06	25												
100	1	20.0	7.4	7.33	25												

Final Water Quality:

Conc (%)	Rep	# Init	Day 1 °C	DO	pH	Sal	# Alive	Day 2 °C	DO	pH	Sal	# Alive	Day 3 °C	DO	pH	Sal	# Alive	Day 4 °C	DO	pH	Sal	# Alive	% Survival
Control	1	10	20.3	7.5	7.62	25	10	19.3	8.0	7.83	25	10	19.9	8.2	7.88	20	10	19.7	8.3	7.97	25	10	100
	2	10	20.3	7.5	7.63	25	10	19.0	8.1	7.88	25	9	19.9	8.2	7.90	26	9	19.6	8.1	7.98	25	9	90
Saline	1	10	20.4	7.5	7.86	25	10	19.0	8.1	8.13	25	10	19.9	8.0	8.10	25	10	19.8	8.1	8.23	25	10	100
	2	10	20.3	7.5	7.90	25	10	19.0	8.2	8.14	25	10	20.0	8.3	8.10	25	10	19.8	8.1	8.30	25	10	100
1.56	1	10	20.2	4.0	7.65	25	10	19.0	8.2	7.95	25	10	20.1	8.4	7.92	26	10	20.1	8.2	7.97	25	10	100
	2	10	20.1	4.0	7.57	25	8	19.0	8.2	7.95	25	8	20.1	8.4	7.91	26	8	20.1	8.3	7.92	25	8	80
3.13	1	10	20.1	4.5	7.55	25	10	19.0	8.2	7.96	25	10	20.0	8.3	7.94	26	10	20.3	8.3	7.88	25	10	100
	2	10	20.1	4.5	7.54	25	10	19.0	8.1	7.97	25	10	20.2	8.3	7.96	26	10	20.2	8.3	7.91	25	10	100
6.25	1	10	20.1	1.6	7.26	25	1	19.0	8.2	7.97	25	1	20.1	8.1	7.88	25	1	19.8	8.2	7.68	25	1	10
	2	10	20.1	1.8	7.27	25	1	19.0	8.2	7.89	24	1	20.0	8.2	7.87	26	1	19.9	8.2	7.61	25	1	10
12.5	1	10	20.0	1.5	7.28	25	0																0
	2	10	20.0	1.5	7.28	25	0																0
25	1	10	20.1	1.0	7.25	25	0																0
	2	10	20.1	1.0	7.25	25	0																0
50	1	10	20.1	0.9	7.26	25	0																0
	2	10	20.1	0.9	7.26	25	0																0
100	1	10	20.1	0.8	7.23	25	0																0
	2	10	20.1	0.8	7.24	25	0																0

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL RESEARCH LABORATORY
27 TARZWELL DRIVE
NARRAGANSETT, RHODE ISLAND 02882

September 18, 1991

MEMORANDUM

SUBJECT: Review of American Samoan report entitled: A Preliminary Toxicity Study of Water, Sediment, and Fish Tissues from Inner Pago Pago Harbor in American Samoa (AECOS, Inc., 1991)

FROM: Brian D. Melzian, Ph.D. Brian
Regional Oceanographer
Region IX/ERL-N

TO: Janet Hashimoto, Chief rec'd 9/23/91
Marine Protection Section (W-7-1)
Region IX

As requested by Region IX's Office of Pacific Island and Native American Programs, I have completed my review of the Pago Pago Harbor report. I commend the American Samoan Environmental Protection Agency (EPA) for supporting the conduct and completion of this important study. Much useful site-specific data and information were obtained that could be used to protect fish, shellfish, and human consumers of fish and shellfish. However, there are some major deficiencies in some of the data and information that should be corrected (see below).

My major conclusions, comments, and recommendations include the following:

I. MAJOR CONCLUSIONS:

° Based on the data presented in this report (i.e., Tables 15A and 15B, pages 22-23), it probably would be prudent to recommend that MULLET (family *Mugilidae*) not be caught or eaten if they are caught in the inner portion of Pago Pago Harbor. Both the muscle and liver tissues of these fish were consistenly found to be contaminated with elevated levels of CHROMIUM and LEAD. In order to appreciate the significance of lead contamination in the mullet, please refer to ATTACHMENT A which describes the potential impacts of lead to fish, wildlife and humans.

I also recommend that ATTACHMENT B, entitled TOXICITY ASSESSEMENT OF DREDGED MATERIALS: ACUTE AND CHRONIC TOXICITY AS DETERMINED BY BIOASSAYS AND BIOACCUMULATION TESTS (Melzian, 1990) be consulted. In particular, the sections on "action limits" and human health risks provide information regarding international standards and risk assessment procedures that could be used to determine if fish or shellfish are safe to eat. Note that the median international standard for lead [i.e., 2 ppm, wet weight (Table 7)] was often exceeded in the mullet samples (see Table 15B).

° It is not appropriate to compare <u>any</u> of the Pago Pago Harbor results with the data and information collected in Hawaii. This is especially true when comparing the geochemical, mineralogical, and geomorphological data. No data or information were included which conclusively demonstrated that the volcanic soils on Hawaii are similar to the volcanic soils on American Samoa. On the contrary, much geological research has shown that the alkali basalts that dominate the upper portions of most oceanic islands produce a much wider range of rock compositions, as compared to the tholeiitic basalts that comprise the ocean floors (see pages 213-218: MARINE GEOLOGY (1982); by James Kennett; Prentice Hall). In addition, the geological "hot spot" that formed the Hawaiian islands is not the same as the volcano that formed American Samoa. Hence, the basalts on American Samoa are probably very different than those found on Hawaii. If the basalts are different, the concentrations of various heavy metals in the sediments, caused by the erosion of the native basalts, will be different.

° The <u>methods</u> section in this report was poorly written. There should have been much more discussion about the analytical methods that were used to measure the metals and organic chemicals in the water, sediment, and tissue samples. In addition, <u>all</u> of the POLYNUCLEAR AROMATIC HYDROCARBON (PAH) data are of very poor quality and are useless in making environmental or human health management decisions. This is because the reported PAH detection limits were extremely high (i.e., up to 12,000 ppb) for the sediment and tissue samples collected at some of the sites (see APPENDIX E). It should have been possible to use analytical procedures that had detection limits as low as 100 ppb (e.g. 0.100 ppm). No wonder the samples were reported as ND (not detected)! THIS HIGH DETECTION LIMIT PROBLEM IS A MAJOR DEFICIENCY OF THIS STUDY, and it should be corrected in future sampling programs. Many of the PAHs are known or suspected animal and human carcinogens [e.g., benozo(a)pyrene], and recent research has linked PAH concentrations in sediments to the incidence of cancer in benthic fish and invertebrates (e.g., oysters and flounder).

° Even though the detection limits for the PCB Aroclors© measured in the sediment and tissue samples were not as high as those for the PAHs, they were still much higher than they should be (see Appendix C). Again, it should have been possible to <u>consistently</u> use detection limits in the 50 to 100 ppb range (or lower) for each Aroclor, versus the 50 to 650 ppb range reported. Since the methods section of the report was so poor, it is impossible to tell if the high detection limit problems were due to; 1) the use of <u>packed</u> Gas Chromatography (GC) columns versus capillary GC columns (preferred); or 2) use of terrestrial hazardous waste or Superfund-Type protocols. If these later protocols were used, I suspect that the cleanup procedures needed to remove such interferences as sulfur (sediments) and lipids (tissue) were not employed. Hence, the high detections limits.

Like some of the PAHs, PCBs are known or suspected animal and human carcinogens; and they are known to accumulate in sediments and bioaccumulate and biomagnify in marine food webs. In particular, Aroclor© 1260 has a greater potential for bioaccumulation (e.g., log K_{OW} = 6.91) than the other Aroclors measured in this study. In fact, only three (3) other "priority pollutants" (one phthalate and two PAHs) have a higher bioaccumulation potential. Hence, it would be prudent to conduct additional studies to determine the areal extent of PCBs contamination in Pago Pago Harbor sediments and biota. To learn more about the bioaccumlation potential of various PCB Aroclors and DDT metabolites, please refer to ATTACHMENT C, entitled Chlorinated Hydrocarbons in Lower Continental Slope Fish Collected near the Farallon Islands, California (Melzian et al., 1987).

° I agree with the report's conclusion that COPPER AND ZINC exceeded the acute and chronic WATER QUALITY CRITERIA established by EPA and/or Hawaii. In addition, the seawater concentrations of LEAD exceeded EPA's 4-day WQC (i.e., 5.6 ug/L) by an order of magnitude. Also note that lead was found elevated in sediments found at sites 3, 4, and 6 (see Table 11) ; and mullet tissues were consistently contaminated with lead. LEAD IS A MAJOR PROBLEM IN PAGO PAGO HARBOR.

° Even though AECOS Inc. made a honest attempt to compare the sediment concentrations with "baseline" sediment concentrations found in Pago Pago Harbor, I feel that this comparison exercise was not scientifically justified. In particular, another major deficiency of this study was the fact that the sediment concentrations were reported as WET WEIGHT measurements versus DRY WEIGHT measurements (preferred). Because the water content of sediments can differ greatly, it has become a standard practise during the past two decades to report sediment chemistry data in DRY WEIGHT units. Unfortunately, this was not done (reason unkown) in this study. Because of this, it is not possible to readily compare the sediment data found in Table 11 with any "baseline" values.

ATTACHNMENT D, entitled Florida's Method for Assessing Metals Contamination in Estuarine Sediments (June 1991) could be used by the American Samoa EPA in the future to help identify sediments with elevated metals contamination. This method does not identify sediments that are toxic; instead, it aids in the identification of sediments that may require additional chemical, biological, or toxicological assessments.

II. MAJOR COMMENTS:

° What is NFR (page 2)?

° Pages 3 and 7 were missing from the report. Why?

° Are the fish which are commonly found in the harbor (page 4), also commonly caught from the harbor by recreational fishermen? If yes, are the fish caught at or near the sites sampled?

° WHOLE FISH should not have been used in this study (page 5). This study would have had much more scientific credibility if muscle and liver tissue samples were resected from the fish before the whole fish was frozen. Why? During the freezing process, ice crystals form in the tissues of the fish and cause the cells to lyse. As a result cross-contamination of the tissues commonly occurs.

° It is not appropriate to use the U.S. EPA classification categories found in Table 7 (page 14). These classification categories were developed for freshwater sediments in the Great Lakes and they are now considered outdated.

° Numerous references were not cited in the REFERENCE section. It would have been beneficial to know where the following references were published so I could have obtained copies, if desired.

- Table 3: Baudo and Muntau, 1990; Kennish, 1989; Bowen, 1979, Dell'Aglio *et al*., 1986; and Krauskopf, 1956.

- Page 9: USEPA, 1986 & 1987.

- Page 12: Nakamura and Sherman, 1958; Shea, 1988; Giesy and Hoke, 1990; DOH, 1978; and Jonasson and Timperley, 1975.

- Table 6: Patterson, 1971; AECOS, 1984; and Lau *et al*., 1973.

- Table 7: Gambrell *et al*., 1983; and Thomas, 1987

- Page 15: Naval Undersea Center, 1974; Morris and Youngberg, 1972; and Youngberg, 1973.

- Page 18: Li, 1984; and Tetra Tech, 1985.

- Page 20: Jensen and Jernelov, 1969; and Bisogni and Lawrence, 1973.

III. RECOMMENDATIONS:

- Because of the detection limit problems previously discussed, it would be appropriate to collect and analyze additional sediment and tissus samples for both PAHs and PCBs. This recommendation also supports AECOS Inc.'s recommendation to collect more sediment samples to "pinpoint the extent and possibly the source of PCB contamination," and fish samples "to determine whether inner Pago Pago Harbor uniquely has a problem with PCB contamination" (page 32).

- If additional sediment samples are collected in the future, ACID VOLATILE SULFIDES (AVS) and TOTAL ORGANIC CARBON (TOC) should be measured in each sample. Much research in recent years has shown that the AVS in sediments control the bioavailability of divalent metals (e.g., copper, cadmium), and TOC controls the bioavailability of nonpolar organic compounds such as DDTs and PCBs. In fact, EPA is now in the process of developing draft Sediment Quality Criteria for nonpolar organics that are based on the "Equilibrium Partitioning Approach." If desired, Region IX could provide the appropriate analytical protocols for the measurement of AVS and TOC in sediments.

- If additional fish samples are collected in the future, the TOTAL LIPIDS content should be determined in the individual muscle and liver tissue samples. By doing this, the chemical contaminant concentrations could be "normalized;" thus facilitating comparisons between the different species of fish caught at the different sites.

- In order to protect the fishermen who may be catching and consuming fish caught in the inner harbor, I recommend that a fish consumption survey be initiated to determine: a) what species are commomly caught in the harbor; b) what species are commonly consumed; and c) how often the fish are caught and consumed by <u>individual</u> fishermen.

- In order to determine the true "baseline" concentrations of heavy metals in American Samoa SOILS or SEDIMENTS, I recommend that the American Samoa EPA conduct a study to determine the concentrations of metals in soils and sediments collected in areas of America Samoa that are known to be free, or relatively free, of anthropogenic contaminants.

- Finally, in order to determine if EPA's national Water Quality Criteria (WQC) for COPPER, ZINC, and LEAD are applicable to American Samoan waters (see page 9 in the report), "site-specific" WQC could be developed using the guidelines found in EPA's Water Quality Standards Handbook (1983). ATTACHMENT E is a copy of Chapter 4 from the handbook and it describes the recalculation, indicator, and resident species procedures that could be used to develop WQC which reflect local environmental conditions. Of the three procedures, the "Indicator Species" procedure may be the most appropriate for American Samoa. In this procedure, acute toxicity in site water and laboratory water is determined. The difference in toxicity values, expressed as a water effect ratio, is used to convert the national WQC to site-specific WQC (see ATTACHMENT E for more details).

§§§§§§§§§§§§§§§§§§§§§§§§

Please note that many of the conclusions, comments, and recommendations made in this memorandum were previously stated in the memorandum I sent to the American Samoa EPA on September 28, 1990 (ATTACHMENT F). Even though some of my previous technical concerns have been addressed since the September, 1990 memorandum, many of them have not (e.g., detection limit problems, recommendations to measure AVS and TOC, lipids in tissues).

If you have any questions or comments about my review, please call me at FTS 838-6163.

ATTACHMENTS (6)

cc: (w/o Attachments)

Norb Jaworski (ERL-N)
Don Phelps (ERL-N)
Jerry Pesch (ERL-N)
Dave Hansen (ERL-N)

Loretta Barsamian (Region IX)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL RESEARCH LABORATORY
27 TARZWELL DRIVE
NARRAGANSETT, RHODE ISLAND 02882

SEPTEMBER 4, 1992

MEMORANDUM

SUBJECT: REVIEW OF "AMERICA SAMOA TOXICITY STUDY: FIELD SAMPLING PLAN" (AUGUST, 1992)

FROM: BRIAN D. MELZIAN, PH.D. Brian
REGIONAL OCEANOGRAPHER
REGION IX/ERL-N

TO: PAT YOUNG
AMERICA SAMOA PROGRAM MANAGER
OFFICE OF PACIFIC ISLAND AND
NATIVE AMERICAN PROGRAMS (E-4)
REGION IX

AS REQUESTED, I HAVE REVIEWED THE AMERICA SAMOA SEDIMENT AND FISH FIELD SAMPLING PLAN. OVERALL, I FEEL THAT THE PLAN IS WELL WRITTEN AND SHOULD PROVIDE THE NECESSARY HIGH QUALITY DATA AND INFORMATION NEEDED TO MAKE INFORMED MANAGEMENT AND REGULATORY DECISIONS. HOWEVER, I DO HAVE SOME SPECIFIC SUGGESTIONS WHICH SHOULD BE CONSIDERED, AND IMPLEMENTED IF POSSIBLE, TO ENSURE THAT THE DATA GENERATED ARE OF VERY HIGH QUALITY. THESE SUGGESTIONS ARE BASED ON: 1) MY EXPERIENCE (9 YEARS) IN DESIGNING AND IMPLEMENTING MARINE MONITORING PROGRAMS; 2) REVIEW OF THE ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM (EMAP)-VIRGINIAN PROVINCE'S 1992 FIELD OPERATIONS MANUAL; AND 3) REVIEW OF EPA'S LATEST DRAFT DOCUMENT ENTITLED:

- FISH SAMPLING AND ANALYSIS: A GUIDANCE DOCUMENT FOR ISSUING FISH ADVISORIES (AUGUST, 1992);

  NOTE: SECTIONS 6 & 7 OF THIS DOCUMENT PROVIDE MUCH USEFUL GUIDANCE
  ****

ALL OF THE SUGGESTIONS MADE BELOW ARE GERMANE TO SECTION V (FIELD METHODS AND PROCEDURES) FOUND ON PAGE 6 OF THE SAMPLING PLAN:

- THE CORE SAMPLER USED TO COLLECT SAMPLES SHOULD BE THOROUGHLY CLEANED WITH ALCONOX®, OR SOME OTHER SUITABLE DETERGENT, AND RINSED WITH FRESH CLEAN SEAWATER BETWEEN SITES.

- IF POSSIBLE, ONLY THE TOP TWO (2) CENTIMETERS OF EACH CORE SHOULD BE SAMPLED FROM EACH CORE. WHY DO THIS? SEDIMENTS DEEPER THAN TWO (2) CENTIMETERS MAY INDICATE HISTORICAL CONTAMINATION VERSUS MORE RECENT CONTAMINATION.

- A TEFLON® (PREFERRED) OR STAINLESS STEEL SPOON SHOULD BE USED TO TO REMOVE THE TOP TWO (2) CENTIMETERS FROM EACH CORE. DURING THIS PROCESS, GREAT CARE SHOULD BE TAKEN TO NOT SAMPLE THE SEDIMENTS THAT ARE AT OR NEAR THE CORE LINER OR TUBE.

- IN ORDER TO OBTAIN THE DESIRED SAMPLE SIZE, MORE THAN ONE CORE PER SITE MAY NEED TO BE SAMPLED AND COMPOSITED. ALL SAMPLES SHOULD BE STORED AND SHIPPED IN CLEAN GLASS CONTAINERS, PREFERABLY WITH TEFLON® LINED LIDS. IF THESE LIDS ARE NOT AVAILABLE, CLEAN ALUMINUM FOIL SHOULD BE USED TO LINE THE LIDS. ALL SAMPLES SHOULD BE FROZEN AS SOON AS POSSIBLE, AND ALL SAMPLES SHOULD BE STORED AT -20°C UNTIL THEY ARE ANALYZED.

- REGARDING THE FISH SAMPLES, I STRONGLY RECOMMEND THAT ALL FISH COLLECTED BE THOROUGHLY RINSED WITH CLEAN SEAWATER TO REMOVE ANY EXTERNAL DEBRIS. THESE FISH SHOULD THEN BE INDIVIDUALLY WRAPPED IN CLEAN ALUMINUM FOIL. AFTER THAT, ALL FISH OF THE SAME SPECIES, AND FROM THE SAME SAMPLING SITE, SHOULD BE PLACED INTO WATERPROOF CLEAN PLASTIC BAGS. AS SOON AS POSSIBLE, THESE SAMPLES SHOULD BE FROZEN AND SHIPPED TO THE LABORATORY. IF SHIPPING TO THE LABORATORY WILL EXCEED 24 HOURS, DRY ICE SHOULD (MUST) BE USED. PLEASE SEE SECTION 6.3.2 (SAMPLE PACKAGING) AND SECTION 6.3.3 (SAMPLE PRESERVATION) IN EPA'S DRAFT FISH SAMPLING GUIDANCE DOCUMENT FOR MORE DETAILS. SIMILAR TO THE SEDIMENT SAMPLES, ALL FISH SAMPLES SHOULD BE STORED AT -20°C UNTIL THEY ARE ANALYZED.

  NOTE: TO MINIMIZE THE CHANCE THAT ANY OF THE SEDIMENT AND FISH
  **** SAMPLES WILL THAW DURING TRANSPORTATION, I STRONGLY RECOMMEND THAT ALL SEDIMENT AND FISH SAMPLES BE STORED AND SHIPPED ON DRY ICE. IF DONE PROPERLY, A 5-10 BLOCK OF DRY ICE IN A COOLER WILL LAST 48 HOURS OR LONGER. RECALL THAT SOME PREVIOUS FISH SAMPLES THAWED BEFORE THEY REACHED THE HAWAII LABORATORY. IF THAWING OCCURS, THE RESULTING ANALYTICAL DATA ARE VERY SUSPECT.

- PLEASE REFER TO SECTION 7 (LABORATORY PROCEDURES), SENT TO YOU ON 9/3/92, FOR THE METHODS THAT SHOULD BE USED TO RESECT (REMOVE) THE MUSCLE SAMPLES FROM THE FROZEN FISH AND TO PRODUCE "COMPOSITE" SAMPLES.

- FINALLY, I STRONGLY RECOMMEND THAT REPLICATE COMPOSITE SAMPLES BE USED IN THIS STUDY FOR SCIENTIFIC AND STATISTICAL REASONS. PLEASE REFER TO SECTIONS 6.1.1.6 (SAMPLE TYPE), 6.1.2.6 (SAMPLE TYPE - INTENSIVE STUDIES), AND 6.1.2.7 (SAMPLE REPLICATION) FOUND IN EPA'S DRAFT FISH SAMPLING GUIDANCE DOCUMENT (AUGUST, 1992) FOR MORE DETAILS.

  PLEASE NOTE: REPLICATE COMPOSITE FISH TISSUE SAMPLES WERE RECENTLY
  *********** USED SUCCESSFULLY IN THE SOUTHERN CALIFORNIA FISH RISK ASSESSMENT STUDY. CONTACT DR. JERRY POLLOCK (CALIFORNIA DHS) FOR MORE DETAILS.

THIS CONCLUDES MY LATEST "BEST PROFESSIONAL JUDGEMENT" INPUT FOR THE AMERICA SAMOA FISH STUDIES. PLEASE CALL ME AT (401) 782-3163 IF YOU HAVE ANY QUESTIONS. GOOD LUCK!!

CC: JANET HASHIMOTO (REGION IX)
RICH PRUELL (ERL-N)
WARREN BOOTHMAN (ERL-N)
DICK LATIMER (EMAP/ERL-N)
RAY VALENTE (EMAP/ERL-N)

David: FYI re: AS. JK

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL RESEARCH LABORATORY
27 TARZWELL DRIVE
NARRAGANSETT, RHODE ISLAND 02882

AUGUST 20, 1992

MEMORANDUM

SUBJECT: REVIEW OF PROPOSED ORGANIC AND INORGANIC CHEMISTRY METHODS TO BE USED IN THE AMERICAN SAMOA FISH BIOACCUMULATION STUDY

FROM: Brian D. Melzian, Ph.D. Brian
Regional Oceanographer (Region IX)
EMAP-VP (ERL-N)

TO: Rich Pruell, Ph.D.
Research Chemist
Exposure Branch (ERL-N)

Today, I received the attached chemistry methods that EPA's Las Vegas laboratory will be using during the analysis of tissue samples obtained from fish collected in American Samoa. Before this important study is undertaken, it is important that my Regional office be assured that the proposed methods are the proper ones to be used.

I and Region IX would greatly appreciate it if you would <u>briefly</u> review the attached methods to determine if: a) they are the appropriate methods to be used in analyzing FISH TISSUE; and b) the reported Method Detection Limits are reasonable <u>and</u> feasible. It is of paramount importance that I (we) determine that the proposed methods are adequate and do <u>not</u> contain any major inadequacies or discrepancies. In addition, should we suggest a specific method for measuring LIPIDS in fish tissues? It may be appropriate to express the reported concentrations as normalized to lipid, in addition to the wet weight concentrations.

On another note, I recently reviewed EMAP's Draft protocol for removing muscle tissue samples from FROZEN fish. Attached is my review of this protocol. As you can see, I believe that the existing protocol is quite good. However, I feel that it could be improved by incoroporating some of the language found in the lastest Draft of EPA's document entitled <u>Fish Sampling and Analysis: A Guidance Document</u> (1992). I intend to submit to Region IX (as "Best Professional Judgement") a method in the near future that the Las Vegas laboratory should use during the resection of the muscle samples from the American Samoa frozen fish.

Thank you in advance for your help in this important matter, and please let me know when you think you can complete your review of the attached chemistry methods. I would like to get back to Region IX as soon as possible.

Attachments

cc: (w/o Attachments) JK 8/24/92
Janet Hashimoto (Region IX)
Pat Young (Region IX)
Norbert Jaworski (ERL-N)
Norm Rubinstein (ERL-N)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

DATE: August 17, 1992

MEMORANDUM

SUBJECT: Proposed Methods for American Samoa Bioaccumulation Study

FROM: Pat Young Pat
American Samoa Program Manager (E-4)

TO: Brian Melzian
Regional Oceanographer
Naragansett Lab

Attached is a copy of the methods being proposed by Pat Mack, Senior Chemist, of the Las Vegas Lab, for analysis of fish liver and tissue for the American Samoa bioaccumulation study of Pago Pago Harbor. I had sent Pat a copy of the comments you and Dave Stuart made after review of the results of the pilot study. As Pat mentions in the last paragraph of her memo, some of the methods which were suggested she did not feel are appropriate for fish tissue and thus the detection levels mentioned for these tests are not achievable utilizing the presently proposed methods.

We would greatly appreciate your review of the analytical methods being proposed. As we discussed, the Las Vegas lab does not have any standard procedures for extraction of the fish tissue and liver so I will forward the procedures you will be getting from your colleague to Pat.

If you have any technical issues which you feel should be discussed directly with Pat, please feel free to call her at (702) 798-2117 (Fax: 702/798-2250). Thanks again for your assistance.

I think I mentioned to you that after our discussion regarding the protocol for spearing fish as a sampling method, I spoke with Sheila Wiegman of ASEPA and she confirmed that this ~~will~~ method will only be used with justification, i.e., all other methods were tried and were unsuccessful.

For your information, we finally were able to have blood samples taken of various populations in American Samoa and these are being analyzed for metals (a total of about 210 people were sampled). The Agency for Toxic Substances and Disease Registry is conducting the study and samples were collected in June/July. We anticipate the report coming out within a few months; however, if there are any elevated levels found, we are supposed to be informed immediately. If you are interested, I will send you a copy of the report when it is completed.

Once again, thanks for your assistance. Call me at (415) 744-1591 if you have any questions or need to discuss anything.

Attachments

8/18/92

cc: Janet Hashimoto (w/o attachment)

4. Any information on stormwater grant?

5. We will be doing the toxicity source investigation here. I am beginning to compile all data & may need your help with some. What I could really use help on — I have some info — is the amounts of heavy metals in petroleum products — diesel, bunker fuel, lube oil. After we get all the existing info, I want to start stream & possibly soil samples for testing. Before we do this I want to compile all existing data & review all possible sources so we get the most bang for our buck. Some information on past military uses is forthcoming. After I compile all the existing data, I'll fax to you guys for help on suggesting sources. Maybe you could check with SWRCB in CA if they've done any similar studies, Puget Sound? I don't need this right away, but maybe we can work on this together over the next few months?

Milzian responded
~ 6/1/92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, Ca. 94105-3901

DATE: February 6, 1992

MEMORANDUM

SUBJECT: Review of Pala Lagoon Toxicity Study

TO: Janet Hashimoto, Chief (W-7-1)
Oceans and Estuaries Section

Arnold Den, Senior Science Advisor
Office of the Regional Administrator

FROM: for Norman L. Lovelace, Chief (E-4) Jim Brand
Office of Pacific Island and Native American Programs

This is to request your office's assistance in reviewing the attached report on the Pala Lagoon Toxicity Study conducted by the American Samoa Environmental Protection Agency. This study is part of the American Samoa Government's attempt to determine whether the environment and fish of frequently used coastal areas are contaminated with toxic compounds. (The study previously reviewed by your staff of Pago Pago Harbor was part of this effort.)

Again, we would greatly appreciate any comments or recommendations from your staff. (A risk assessment evaluation based on this study is also being requested from your staff Arnold.)

Regarding follow up on the Pago Pago Harbor study, it is likely that the Agency for Toxic Substances and Disease Registry (ATSDR) will be conducting a study to evaluate heavy metal exposure of the population related to fish consumption. Two staff members were in American Samoa last month on an initial site visit. A request will also be made soon by the American Samoa Government to the Department of Interior for funding of Phase II of the Pago Pago Harbor and Surrounding Waters Toxicity Study.

Thank you again for your valuable assistance to American Samoa.

Attachment

cc: Gwen Eng, ATSDR R9

Rcd 2/6/92

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY
Serial:23
January 30, 1992

Pat Young
American Samoa Project Manager
Office of Pacific Islands & Native
American Programs
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

Dear Pat:

Enclosed is a report on the Pala Lagoon Toxicity Study. A description of the procedure and the AECOS results are provided here. We would appreciate it if USEPA staff could review the information, provide comments, and complete a risk assessment evaluation, if warranted. Dr. James Walker of CDC and Gwen Eng of ASTDR are aware we have completed the testing, though we had not fully reviewed the date when they visited Samoa. High lead levels were not evident, though arsenic and chromium may be of concern.

I spoke with Bonnie Ponwith of the American Samoa Department of Marine & Wildlife Resources who states people living in the Pala Lagoon area generally consume 1 meal per week of fish from Pala Lagoon itself. She states the amount consumed is approximately one-half pound per meal. Bonnie is now completing an analysis of fishing from this area from a year long survey (Bonnie in her kayak at night!). Let me know if you need any further information.

We have not yet submitted the proposal for further environmental assessment for toxicity as Governor Coleman has been off-island. A copy will be sent to you as soon as he signs it.

Tofa Soifua,

Sheila

Sheila Wiegman
Environmental Coordinator
American Samoa Environmental
Protection Agency

cc: Environmental Coordinator, ASEPA

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

Pala Lagoon Toxicity Testing

January 1992

Background

The American Samoa Environmental Protection Agency (ASEPA) and Department of Marine and Wildlife Resources (DMWR) seek to determine whether toxic compounds are present in the environment and fishery resources of frequently utilized habitats in American Samoa. A pilot study on inner Pago Pago Harbor was completed in 1990-91 resulting in a fish consumption advisory for the area due to high metals concentrations. Further study on a territory-wide basis is currently being pursued.

Fishery and harvesting commonly occur in Pala Lagoon, the only large well protected lagoon on Tutuila Island. Extensive stands of red and oriental mangroves are located along the eastern and northern shores of the lagoon. This area is considered important as a nursery and spawning ground for many of the fish and invertebrates found on the reef. Testing of commonly consumed species from this area was considered a priority because of its frequent use and the increasing settlement and human use of the surrounding land area which could contribute toxic pollutants to the area.

Procedure

Species commonly consumed and abundant enough for testing were chosen and collected. These species include:

Species	Common Name	Type of Feeder
Valamugil engeli	mullet	detritivore
Sylla serrata	crab	omnivore (clams, crabs, shrimp fish)
Gafrarium	clam	planktivore (filter feeder)
Caranx spp	jacks	carnivore
Upeneus vittatus	goatfish/mojarra	carnivore (benthic invertebrates)
Liza vaigiensis	mullet	detritivove
Lutjanus fuluus	snapper	piscivivove
Liza melanoptra	mullet	detritivove

Specimens were collected August 9-11, 1991. Juvenile and adult fish were captured with 8 monofilament gillnets located at three stations along the northern and western shorelines; a fyke net was fished to the south of the gillnets near the airport (Figure 1). Crabs were collected with

5 baited wiremesh traps which were fished in the western end of the lagoon. All gear was fished continuously for 24 hours and emptied at 6 hour intervals. Clam specimens were obtained by hand digging along the northeast shorelines.

Upon recovery, all specimens (whole) were immediately placed in food grade plastic bags, packed in iced coolers, and transported to lab freezers. On August 14, 1991, frozen specimens, were air freighted to AECOS. Analysis for heavy metals, polychlorianted byphenyls (PCBs), and chlorinated pesticides was completed. Petroleum hydrocarbons and volatile organic compounds (VOCs) were not tested for. There are few sources that would yield petroleum contamination in the area. Due to funding constraints and as VOCs were not present in inner Pago Pago Harbor sediments or fish (a worst case scenario), these were not tested in Pala Lagoon.

Study Results

The data from AECOS Lab is available in Attachment 1. No pesticides or PCBs were found int he fish tissue. The tables included here provide a summary of the Pala Lagoon data as compared to the inner Pago Pago Harbor results. Table 3 contains the range of legal limits for fish tissue from around the world.

Discussion

On the average, the metals concentrations for fish tissue in Pala Lagoon are similar to or less than that found in inner Pago Pago Harbor. Arsenic and chromium are within or exceed the Range of Legal Limits. Legal limits are not available for nickel and silver.? The chromium concentration is at the limit or exceeded for all species, though crab, clams, and jacks show particularly high concentrations. Both metals posed risk for consumption of fish caught from inner Pago Pago Harbor based on USEPA risk assessment calculations. These chemicals likely result from a similar sources at both locations.

Recommendations

1. A risk assessment calculation or evaluation by USEPA should be completed with particular focus on arsenic and chromium. The USEPA evaluation may provide insight to interpretation of nickel and silver results.

2. The environmental sources for arsenic and chromium should be investigated and remediated as possible. Sediment and other testing may be necessary.

3. Any fish consumption activities should be determined based on USEPA evaluation and in conjunction with the Department of Health.

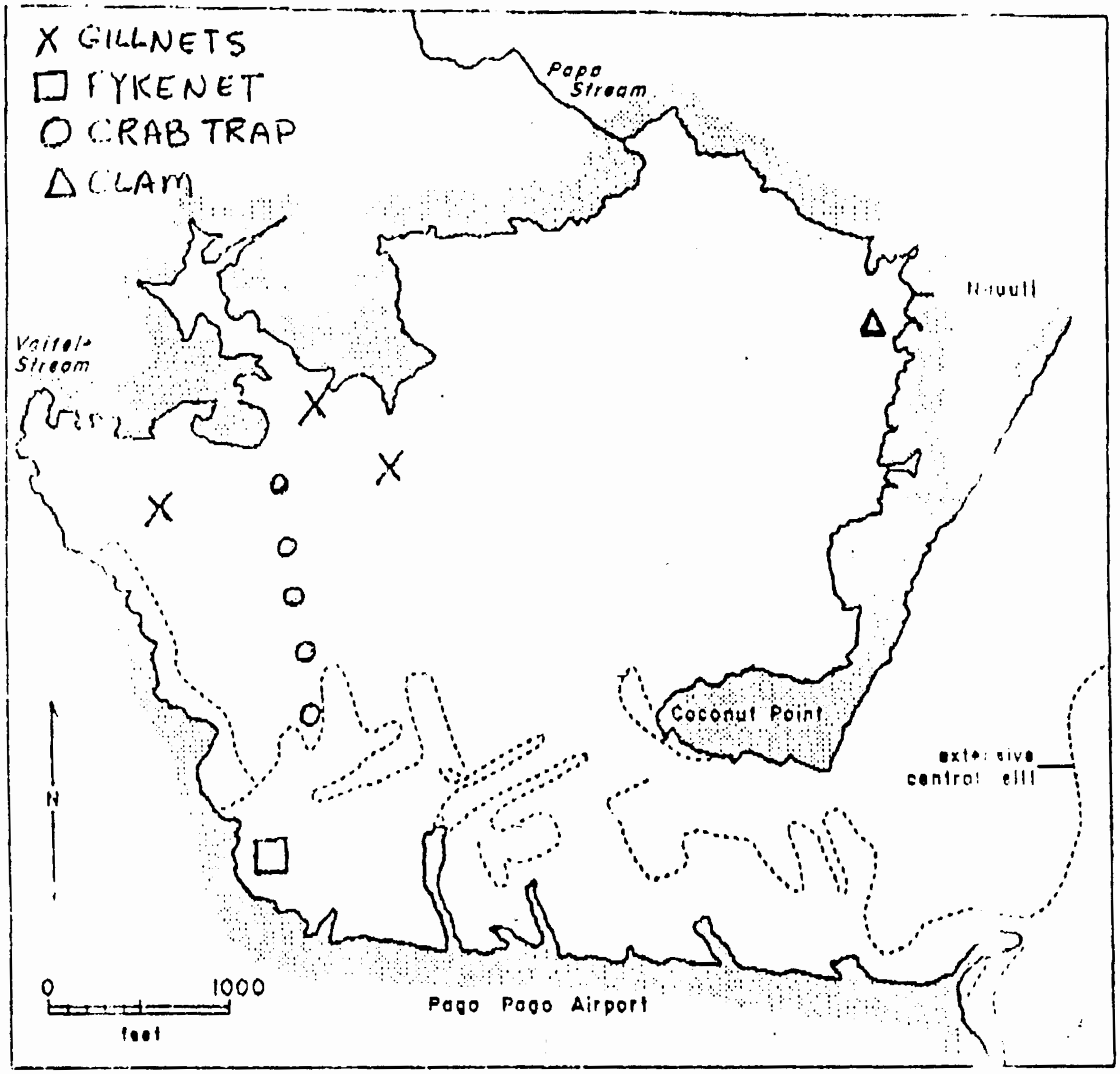

Figure 1. Pala Lagoon, American Samoa

Table 1. Comparison of Pala Lagoon and Pago Harbor for 90-91 toxicity results (mg/kg wet weight) for muscle tissue.

Taxa Species	As		Cd		Cr		Cu		Pb		Hg		Ni		Ag		Zn	
	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago
FISH																		
Mullet (Mean for 3 species)	0.71	0.08	0.20	0.26	1.47	8.06	0.67	4.94	0.04	3.73	0.01	0.01	1.00	4.07	0.20	0.26	4.67	15.53
Standard deviation	0.26	0.05		0.17	0.34	9.66	0.66	3.54		3.05	0.00	0.00	0.00	2.94		0.24	1.65	2.22
Snapper (Lutjanus fulvus)	0.05	0.01	0.2	0.33	1.3	4.6	0.2	0.46	0.04	2.5	0.026	0.08	1.0	4.1	0.2	0.13	4.0	12.2
Jacks (Caranx/Urapsis)	0.48	0.01	0.2	0.37	27.4	5.5	0.2	0.29	0.04	1.9	0.019	0.05	1.0	3.1	0.2	0.15	10.9	23.0
Goatfish/Mojarra (Upeneus/Gerres)	0.79	0.03	0.2	0.30	2.3	33.8	0.8	1.32	0.04	1.6	0.032	0.01	1.0	11.8	0.2	0.45	2.9	16.5
Surgeonfish (Acanthuridae spp.)		0.01		0.20		1.9		0.61		1.1		0.06		1.3		0.26		9.3
Surgeonfish (A. xanthopterus)		0.026		0.10		0.48		5.62		0.1		0.01		0.1		0.05		3.6
Mean	0.51	0.03	0.20	0.26	8.12	9.06	0.47	2.21	0.04	1.82	0.02	0.04	1.00	4.08	0.20	0.22	5.62	13.36
Standard deviation	0.29	0.03	0.00	0.09	11.14	11.53	0.27	2.20	0.00	1.13	0.01	0.03	0.00	3.74	0.00	0.13	3.11	6.06
	0.1-10		0-5.5		1.0		10-100		0.5-10		0.1-1.0						30-1000	
INVERTEBRATES																		
Clams (Gafrarium tumidum)	1.14		0.2		9.8		1.7		0.12		0.023		2.0		0.2		9.4	
Crabs (Scylla serrata)	2.54		0.2		2.6		11.0		0.04		0.039		1.0		0.2		37.3	
Mean	1.84		0.20		6.20		6.35		0.08		0.03		1.50		0.20		23.35	
Standard deviation	0.70		0.00		3.60		4.65		0.04		0.01		0.50		0.00		13.95	
ALL SPECIES																		
Mean	0.95	0.03	0.20	0.26	7.48	9.06	2.43	2.21	0.05	1.82	0.03	0.04	1.17	4.08	0.20	0.22	11.53	13.36
Standard deviation	0.78	0.03		0.09	9.37	11.33	3.87	2.20	0.03	1.13	0.01	0.03	0.37	3.74		0.13	11.88	6.06

Table 2. Comparison of Pala Lagoon and Pago Harbor 1990-91 toxicity results (mg/kg wet weight)for liver and organ tissues.

[illegible]	As		Cd		Cr		Cu		Pb		Hg		Ni		Ag		Zn	
	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago	Pala	Pago
Mullet (V.engeli/Mugilidae spp.*)	1.32	0.32	0.40	0.21	2.70	6.72	30.00	8.09	0.37	25.40	0.06	0.02	2.00	2.03	0.40	0.28	57.20	25.47
(Scylla serrata)	1.55		0.50		16.90		56.20		0.04		0.03		1.00		0.20		47.70	
Mojarra (Gerres spp.)		0.60		0.40		44.10		3.00		3.60		0.12		11.60		0.40		45.70
Mean for 3 Surgeonfish species		0.32		0.28		4.73		8.41		0.90		0.28		1.53		0.38		112.97
Jacks (Urapsis spp.)		0.37		1.30		5.50		5.50		1.40		0.06		1.20		0.70		32.90
Mean	1.44	0.40	0.45	0.55	9.80	15.26	43.10	6.25	0.21	7.83	0.04	0.12	1.50	4.09	0.30	0.44	52.45	54.26
Standard deviation	0.12	0.12	0.05	0.44	7.10	16.66	13.10	2.19	0.17	10.20	0.01	0.10	0.50	4.35	0.10	0.16	4.75	34.66
	0.1-10		0-5.5		1.0		10-100		0.5-10		0.1-1.0						30-1000	

* Mean of 3 Mugilidae spp.

TABLE 3

Range of Legal Limits for Metals in Fish Tissue

Metal	Limits (ppm)
As	0.1-10
Cd	0-5.5
Cr	1.0
Cu	10-100
Pb	0.5-10
Hg	0.1-1.0
Ni	-
Ag	-
Zn	30-1000

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Telephone: (808) 254-5884

12/23/91

Ms. Sheila Wiegman
Amercian Samoa Government
Office of the Governor EPA
PagoPago, American Samoa 96799

RE: Toxicity Testing for Pala Lagoon

Dear Sheila,

We are submitting the data report and invoice for the Pala Lagoon study. We are sorry it took so long to finish, but we were having some clean-up problems with the samples to be run for pesticides and PCBs.

No pesticides or PCBs were found in any of the samples and all results are reported as less than the detection limits. All numbers are reported on a wet weight basis, as was the PagoPago study.

If you have any questions regarding any of the analysis, please call us. We will be closed on Christmas day and New Years day.

Happy Holidays,

Snookie Mello

Snookie Mello

AECOS
970 N. Kalaheo Ave., Suite C311
Kailua, Hawaii 96734

JOB: 65
DATE: 12/23/91

TO: American Samoa Government EPA
PROJECT: Pala Lagoon Toxicity Study
RECEIPT DATE: 08/15/91

ATTN: Sheila Wiegman
AMPLED: Aug 9 1991
LOG NO: [5181-5188]

ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

Valamugil engeli

	Mullet muscle [5181]	Mullet muscle Dup. [5181]	Spike % Recovery
Aldrin	<0.008	<0.008	
Alpha-BHC	<0.008	<0.008	
Beta-BHC	<0.015	<0.015	
Delta-BHC	<0.008	<0.008	
Lindane	<0.008	<0.008	
Chlordane	<0.008	<0.008	
4,4'DDD	<0.015	<0.015	
4,4'DDE	<0.015	<0.015	
4,4'DDT	<0.015	<0.015	
Dieldrin	<0.008	<0.008	
Endosulfan I	<0.008	<0.008	
Endosulfan II	<0.008	<0.008	
Endosulfan Sulfate	<0.015	<0.015	
Endrin	<0.015	<0.015	
Endrin Aldehyde	<0.015	<0.015	
Heptachlor	<0.008	<0.008	
Heptachlor Epoxide	<0.008	<0.008	
Menoxychlor	<0.02	<0.02	
Toxaphene	<0.20	<0.20	
Arochlor 1016	<0.12	<0.12	
Arochlor 1221	<0.5	<0.5	
Arochlor 1232	<0.25	<0.25	
Arochlor 1242	<0.20	<0.20	
Arochlor 1248	<0.12	<0.12	
Arochlor 1254	<0.09	<0.09	
Arochlor 1260	<0.08	<0.08	127%

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

<u>*Sylla serrata*</u>

	Crab muscle [5182]	Crab muscle Dup [5182]	Spike % Recovery
Aldrin	<0.008	<0.008	
Alpha-BHC	<0.008	<0.008	
Beta-BHC	<0.015	<0.015	
Delta-BHC	<0.008	<0.008	
Lindane	<0.008	<0.008	
Chlordane	<0.008	<0.008	75%
4,4'DDD	<0.015	<0.015	
4,4'DDE	<0.015	<0.015	
4,4'DDT	<0.015	<0.015	
Dieldrin	<0.008	<0.008	
Endosulfan I	<0.008	<0.008	
Endosulfan II	<0.008	<0.008	
Endosulfan Sulfate	<0.015	<0.015	
Endrin	<0.015	<0.015	
Endrin Aldehyde	<0.015	<0.015	
Heptachlor	<0.008	<0.008	
Heptachlor Epoxide	<0.008	<0.008	
Menoxychlor	<0.02	<0.02	
Toxaphene	<0.20	<0.20	
Arochlor 1016	<0.12	<0.12	
Arochlor 1221	<0.5	<0.5	
Arochlor 1232	<0.25	<0.25	
Arochlor 1242	<0.20	<0.20	
Arochlor 1248	<0.12	<0.12	
Arochlor 1254	<0.09	<0.09	
Arochlor 1260	<0.08	<0.08	

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ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

<u>Sylla serrata</u>

	Crab Organs & Gills [5182]	Crab Organs & Gills Dup [5182]	Spike % Recovery
Aldrin	<0.032	<0.032	
Alpha-BHC	<0.032	<0.032	
Beta-BHC	<0.06	<0.06	
Delta-BHC	<0.032	<0.032	
Lindane	<0.032	<0.032	
Chlordane	<0.032	<0.032	
4,4'DDD	<0.06	<0.06	
4,4'DDE	<0.06	<0.06	
4,4'DDT	<0.06	<0.06	
Dieldrin	<0.032	<0.032	
Endosulfan I	<0.032	<0.032	
Endosulfan II	<0.032	<0.032	91%
Endosulfan Sulfate	<0.06	<0.06	
Endrin	<0.06	<0.06	
Endrin Aldehyde	<0.06	<0.06	
Heptachlor	<0.032	<0.032	
Heptachlor Epoxide	<0.032	<0.032	
Menoxychlor	<0.08	<0.08	
Toxaphene	<0.8	<0.8	
Arochlor 1016	<0.48	<0.48	
Arochlor 1221	<2.0	<2.0	
Arochlor 1232	<1.0	<1.0	
Arochlor 1242	<0.8	<0.8	
Arochlor 1248	<0.48	<0.48	
Arochlor 1254	<0.36	<0.36	
Arochlor 1260	<0.32	<0.32	

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ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

	Lutjanus fulvus Snapper [5183]	*Liza vaigiensis* Large mullet [5184]	*Liza melanoptera* Med. mullet [5185]	*Upeneus vittatus* Goatfish [5187]
Aldrin	<0.008	<0.008	<0.008	<0.008
Alpha-BHC	<0.008	<0.008	<0.008	<0.008
Beta-BHC	<0.015	<0.015	<0.015	<0.015
Delta-BHC	<0.008	<0.008	<0.008	<0.008
Lindane	<0.008	<0.008	<0.008	<0.008
Chlordane	<0.008	<0.008	<0.008	<0.008
4,4'DDD	<0.015	<0.015	<0.015	<0.015
4,4'DDE	<0.015	<0.015	<0.015	<0.015
4,4'DDT	<0.015	<0.015	<0.015	<0.015
Dieldrin	<0.008	<0.008	<0.008	<0.008
Endo-sulfan I	<0.008	<0.008	<0.008	<0.008
Endo-sulfan II	<0.008	<0.008	<0.008	<0.008
Endosulfan Sulfate	<0.015	<0.015	<0.015	<0.015
Endrin	<0.015	<0.015	<0.015	<0.015
Endrin Aldehyde	<0.015	<0.015	<0.015	<0.015
Heptachlor	<0.008	<0.008	<0.008	<0.008
Heptachlor Epoxide	<0.008	<0.008	<0.008	<0.008
Menoxychlor	<0.02	<0.02	<0.02	<0.02
Toxaphene	<0.20	<0.20	<0.20	<0.20
Arochlor				
1016	<0.12	<0.12	<0.12	<0.12
1221	<0.5	<0.5	<0.5	<0.5
1232	<0.25	<0.25	<0.25	<0.25
1242	<0.20	<0.20	<0.20	<0.20
1248	<0.12	<0.12	<0.12	<0.12
1254	<0.09	<0.09	<0.09	<0.09
1260	<0.08	<0.08	<0.08	<0.08

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

Caranx spp

	Whole Jacks [5188]	Whole Jacks Dup [5188]	Spike % Recovery
Aldrin	<0.008	<0.008	
Alpha-BHC	<0.008	<0.008	
Beta-BHC	<0.015	<0.015	
Delta-BHC	<0.008	<0.008	
Lindane	<0.008	<0.008	
Chlordane	<0.008	<0.008	
4,4'DDD	<0.015	<0.015	
4,4'DDE	<0.015	<0.015	
4,4'DDT	<0.015	<0.015	
Dieldrin	<0.008	<0.008	
Endosulfan I	<0.008	<0.008	
Endosulfan II	<0.008	<0.008	73%
Endosulfan Sulfate	<0.015	<0.015	
Endrin	<0.015	<0.015	
Endrin Aldehyde	<0.015	<0.015	
Heptachlor	<0.008	<0.008	
Heptachlor Epoxide	<0.008	<0.008	64%
Menoxychlor	<0.02	<0.02	
Toxaphene	<0.20	<0.20	
Arochlor 1016	<0.12	<0.12	
Arochlor 1221	<0.5	<0.5	
Arochlor 1232	<0.25	<0.25	
Arochlor 1242	<0.20	<0.20	
Arochlor 1248	<0.12	<0.12	
Arochlor 1254	<0.09	<0.09	
Arochlor 1260	<0.08	<0.08	

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Pesticides (mg/kg wet weight)

<u>*Gafrarium tumidum*</u>

	Mud Clams [5186]	Mud Clams Dup [5186]	Spike % Recovery
Aldrin	<0.008	<0.008	
Alpha-BHC	<0.008	<0.008	
Beta-BHC	<0.015	<0.015	
Delta-BHC	<0.008	<0.008	
Lindane	<0.008	<0.008	
Chlordane	<0.008	<0.008	
4,4'DDD	<0.015	<0.015	
4,4'DDE	<0.015	<0.015	
4,4'DDT	<0.015	<0.015	
Dieldrin	<0.008	<0.008	
Endosulfan I	<0.008	<0.008	
Endosulfan II	<0.008	<0.008	
Endosulfan Sulfate	<0.015	<0.015	
Endrin	<0.015	<0.015	
Endrin Aldehyde	<0.015	<0.015	
Heptachlor	<0.008	<0.008	
Heptachlor Epoxide	<0.008	<0.008	
Menoxychlor	<0.02	<0.02	
Toxaphene	<0.20	<0.20	
Arochlor 1016	<0.12	<0.12	
Arochlor 1221	<0.5	<0.5	
Arochlor 1232	<0.25	<0.25	
Arochlor 1242	<0.20	<0.20	
Arochlor 1248	<0.12	<0.12	
Arochlor 1254	<0.09	<0.09	102%
Arochlor 1260	<0.08	<0.08	

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Metals (mg/kg wet weight)
Valamugil engeli

	Blank	Mullet muscle [5181]	Mullet muscle Dup [5181]	Spike % Recovery
Arsenic	<0.05	0.65	0.50	35%
Cadmium	<0.2	<0.2	<0.2	89%
Chromium	<0.5	1.8	2.0	94%
Copper	<0.2	1.6	1.9	102%
Lead	<0.04	0.04	0.12	92%
Mercury	<0.007	0.010	0.010	123%
Nickel	<1.0	<1.0	<1.0	84%
Silver	<0.2	<0.2	<0.2	81%
Zinc	<0.1	7.0	7.2	100%

	Liver [5181]	Liver Dup [5181]	Spike % Recovery
Arsenic	1.32	1.01	74%
Cadmium	<0.4	<0.4	92%
Chromium	2.7	2.5	90%
Copper	30.0	29.9	105%
Lead	0.37	0.19	91%
Mercury	0.055	0.060	112%
Nickel	<2.0	<2.0	99%
Silver	<0.4	<0.4	96%
Zinc	57.2	59.4	100%

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Metals (mg/kg wet weight)
Sylla serrata

	Crab muscle [5182]	Crab muscle Dup [5182]	Spike % Recovery
Arsenic	2.54	2.81	112%
Cadmium	<0.2	<0.2	90%
Chromium	2.6	2.8	87%
Copper	11.0	11.2	85%
Lead	<0.04	<0.04	110%
Mercury	0.039	0.040	124%
Nickel	<1.0	<1.0	100%
Silver	<0.2	<0.2	85%
Zinc	37.3	38.2	90%

	Crab Organs & Gills [5182]	Crab Organs & Gills Dup [5182]	Spike % Recovery
Arsenic	1.55	1.56	93%
Cadmium	0.5	0.4	93%
Chromium	16.9	20.2	94%
Copper	56.2	53.7	112%
Lead	<0.04	<0.04	89%
Mercury	0.033	0.021	124%
Nickel	<1.0	<1.0	101%
Silver	0.2	0.2	86%
Zinc	47.7	49.4	95%

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Metals (mg/kg wet weight)

	Lutjanus fulvus Snapper [5183]	*Liza vaigiensis* Large mullet [5184]	*Liza melanoptera* Med. mullet [5185]	*Upeneus vittatus* Goatfish [5187]
Arsenic	<0.05	1.06	0.42	0.79
Cadmium	<0.2	<0.2	<0.2	<0.2
Chromium	1.3	1.0	1.6	2.3
Copper	<0.2	<0.2	<0.2	0.8
Lead	<0.04	<0.04	<0.04	<0.04
Mercury	0.026	0.013	0.008	0.032
Nickel	<1.0	<1.0	<1.0	<1.0
Silver	<0.2	<0.2	<0.2	<0.2
Zinc	4.0	3.4	3.6	2.9

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JOB NO 657
PALA LAGOON

ASEPA BIOACCUMULATION

Metals (mg/kg wet weight)

Gafrarium tumidum

	Clams [5186]	Clam Dup [5186]	Spike % Recovery
Arsenic	1.14	1.11	70%
Cadmium	<0.2	<0.2	95%
Chromium	9.8	12.3	82%
Copper	1.7	1.7	110%
Lead	0.12	0.16	86%
Mercury	0.023	0.025	140%
Nickel	2.0	1.0	99%
Silver	<0.2	<0.2	60%
Zinc	9.4	9.1	105%

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ASEPA BIOACCUMULATION

Metals (mg/kg wet weight)

Caranx spp

	Whole Jacks [5188]	Whole Jacks Dup [5188]	Spike % Recovery
Arsenic	0.48	0.70	43%
Cadmium	<0.2	<0.2	91%
Chromium	27.4	29.4	103%
Copper	<0.2	<0.2	110%
Lead	<0.04	<0.04	76%
Mercury	0.019	0.016	120%
Nickel	<1.0	<1.0	91%
Silver	<0.2	<0.2	89%
Zinc	10.9	11.0	105%

AECOS

970 N. Kalaheo Avenue, Suite A300 • Kailua, Hawaii 96734
Telephone: (808) 254-5884

CHAIN OF CUSTODY

Client: AS EPA
Address: Office of the Governor
PAGO PAGO, AS 96799

Contact person: SHEILA WIEGMAN
Phone #: (684) 633-2304
PO #: NA
Project: PALA TOXICITY STUDY

Special Handling Request
- ☐ Rush
- ☐ Verbal
- ☒ Other Letter already sent

Sample ID	Date	~~Time~~	~~Grab~~	Comp	No. of Containers	Waste Type	Preservation	Analyses request
Valamugil engeli	9 AUG 91	5181			11	—	FROZEN	INSTRUCTIONS SENT:
Sylla serrata	↓	5182			5	—	↓	METALS, PESTICIDES, PCBs
Gafrarium tumidum	↓	5186			2	—	↓	WITH SPIKE & DUPLICATE FOR
Caranx spp.	↓	5189			1		↓	EACH TISSUE.
Upeneus vittatus	↓	5187			1		↓	
Liza vaigiensis	↓	5184			1		↓	
Lutjanus fulvus	↓	5183			1		↓	
LIZA MELANOPTERA	↓	5185			1		↓	

Disposal of oil samples, solvent samples, and samples deemed hazardous by AECOS are the responsibility of the client.

Collected by: Pamela KNUDSEN, AS DMWR	Delivery by: Date: Time:
Received by: Snookie Mello Date: 8/15/91 Time: 1310	Relinquished by: Date: Time:
Received by: Date: Time:	Relinquished by: Date: Time:
Received for laboratory by: Date: Time:	Comments (Precautions/hazards): NONE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL RESEARCH LABORATORY
27 TARZWELL DRIVE
NARRAGANSETT, RHODE ISLAND 02882

November 25, 1991

MEMORANDUM

SUBJECT: Transmittal of "A STUDY OF CHEMICAL CONTAMINATION OF MARINE FISH FROM SOUTHERN CALIFORNIA: II. COMPREHENSIVE STUDY" (September, 1991)

FROM: Brian D. Melzian, Ph.D. Brian
Regional Oceanographer
Region IX/ERL-N

TO: Janet Hashimoto & David Stuart 12/3/91
Marine Protection Section (W-7-1)
Region IX

Attached, please find copies of the following documents that describe the results of the recently completed fish contamination study conducted by the California Environmental Protection Agency:

1 to DS ✓ 1. Two (2) copies of the September 23, 1991 press released entitled "Toxics Warnings Issued On Some South Coast Sports Fish;"

" ✓ 2. Two (2) copies of the EXECUTIVE SUMMARY of the comprehensive study;

" ✓ 3. Two (2) copies of the Preface, Acknowledgements, Table of Contents, and Executive Summary sections taken directly from the final report; and

I put in Section Library 4. One (1) copy of the entire study entitled "A STUDY OF CHEMICAL CONTAMINATION OF MARINE FISH FROM SOUTHERN CALIFORNIA: II. COMPREHENSIVE STUDY" (September, 1991):

- Note that Region IX was cited for our assistance in the Acknowledgements Section of this study.
- ALSO NOTE THAT THIS ENTIRE REPORT COULD BE USEFUL TO THE AMERICAN SAMOA GOVERNMENT DURING THE DEVELOPMENT OF THE SECOND PHASE OF THE PAGO PAGO HARBOR STUDY. In particular, note the sections on the design of the comprehensive study, materials and methods (e.g., Method Detection Limit Determination), QA/QC, Statistical Analysis, and Health Evaluation.

I recommend that Region IX send the complete study to the American Samoan EPA to assist in the final design of their fish contamination study. In a week or so, I will also send some additional information and recommendations that could be used during the development and implementation of the the Pago Pago Harbor Phase II study.

If you have any questions, please call me at FTS 838-6163.

Attachments (4)

cc: Jerry Pesch (ERL-N)

California Environmental Protection Agency

Air Resources Board • Department of Pesticide Regulation • Department of Toxic Substances Control • Integrated Waste Management Board
Office of Environmental Health Hazard Assessment • State Water Resources Control Board • Regional Water Quality Control Boards

Pete Wilson
Governor

James M. Strock
Secretary for Environmental Protection

FOR RELEASE MONDAY
SEPTEMBER 23, 1991

Contact: Jerry Pollock, OEHHA
916/327-7319

Toxics Warnings Issued On Some South Coast Sports Fish

SACRAMENTO -- The California Environmental Protection Agency today reaffirmed that some species of fish caught along the coast between Santa Monica and Newport Bay should be consumed in limited quantities or avoided altogether because of elevated levels of DDT and polychlorinated biphenyls (PCBs).

The State has issued warnings on one fish species in Southern California for six years. Today, consumption guidelines for several fish species and sites were issued by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA).

"We want to assure the public that most fish are still safe for consumption," said James M. Strock, Secretary for Environmental Protection. "But this study underscores the continuing consequences of heedless environmental practices in the past. We have made major strides toward eliminating this marine contamination, but we must be mindful that some deleterious health risks remain as an unwelcome legacy."

The OEHHA guidelines resulted from a major, four-year study of sports fish contamination along the Southern California coast.

The study identified white croaker, a bottom-feeding fish commonly known as tom cod or kingfish, as the only species with such high contamination that OEHHA recommends against consumption. State warnings about white croaker have been issued to sport fishermen annually since 1985; the fish has been banned from commercial fishing off the Palos Verdes Peninsula since 1990.

"Eating seafood once or twice a week is beneficial for most individuals and is a recommended part of the diet," said Dr. Steven Book, Acting Director of OEHHA. "Anglers just need to be careful about eating specific fish caught in certain places."

OEHHA recommends that white croaker be avoided in most areas and that four other species--corbina, queenfish, surfperches and sculpin--be limited to one or two meals a month.

- MORE -

General guidelines for consuming sports fish caught in the area also include:

- Fishing at several different locations and eating a variety of fish to avoid the risk of eating one more highly contaminated species from a more contaminated site;

- Trimming fat from fillets and baking or broiling fish on a rack to reduce the intake of fat where DDT and PCBs are stored.

Sites found in the study to be more highly contaminated include White's Point, Los Angeles-Long Beach harbors and Horseshoe Kelp. Guidelines for consumption of fish caught in these specific areas and others included in the study are being issued, and will be printed in the 1992 edition of the California sport fishing regulations issued by the Department of Fish and Game.

The study by OEHHA, in cooperation with the Department of Fish and Game, was conducted because of concerns about industrial pollutants that were discharged or dumped into the ocean during the 1960s and 1970s. Contaminants -- including deposits of DDT estimated at several million pounds -- were carried into the ocean primarily from sewage discharges, as well as from storm drains and river drainage, waste dumping from barges and other unidentified sources. Pollution controls such as industrial pre-treatment programs have greatly reduced these discharges; however, DDT and PCBs break down very slowly in the environment.

A total of 15 different species of fish were sampled, with 5 to 10 different species collected from each of 24 sites representing areas fished by pier, private boat and party boat anglers. Nearly 4,000 fish were sampled and approximately 1,000 chemical analyses were performed during the study.

FOR MORE INFORMATION:

A free summary report of the study is available from the Office of Environmental Health Hazard Assessment, 714 P Street, Room 460, Sacramento, CA 95814, 916/324-7572.

Copies of the full 400-page report may be purchased for $14.00 from Copies Unlimited, 5904 Sunset Boulevard, Los Angeles, CA 90028, 213/462-5532.

-- 30 --

Southern California Coastal Fish Advisory
Site-specific Consumption Guidelines

Site	Fish Species	Recommendation[1]
Marina Del Rey Huntington Beach Fourteen Mile Bank Laguna Beach Redondo Beach Emma/Eva oil platforms Catalina (Twin Harbors) Santa Monica Pier Venice Pier Venice Beach Dana Point	All species	No restrictions
Newport Pier Redondo Pier	Corbina "	One meal every two weeks
Belmont Pier Pier J	Surfperches "	One meal every two weeks
Malibu Pier	Queenfish	One meal a month
Short Bank	White croaker	One meal every two weeks
Malibu Point Dume	White croaker "	Do not consume
Point Vicente Palos Verdes—Northwest	White croaker "	Do not consume
White's Point	White croaker	Do not consume
	Scuplin Rockfishes Kelp bass	One meal every two weeks[2]
Los Angeles/ Long Beach Harbors (esp. Cabrillo Pier)	White croaker	Do not consume
	Queenfish Black croaker Surfperches	One meal every two weeks[2]
Los Angeles/ Long Beach Breakwater (ocean side)	White croaker Queenfish Surfperches Black croaker	One meal a month[2]
Horseshoe Kelp	Sculpin White croaker	One meal a month[2]

[1] Maximum recommended frequency; one meal is about six (6) ounces.
[2] Consumption recommendation is for all the listed species combined

Questions about the Fish Survey and Consumption Advisory

What was the study area?
A total of 24 sites were selected, from Point Dume in northern Los Angeles County to Dana Point in southern Orange County. Sampling sites were chosen after consultation with experts from the Department of Fish and Game, the U.S. Environmental Protection Agency, consultants, and the Department of Health Services (DHS). All collecting sites were frequently fished and were selected to represent the three types of fishing activities: pier, private boat and party boat fishing.

Party and private boat sites sampled in the study were off-shore near Point Dume, Malibu, Marina del Rey, Short Bank, Redondo Beach, Palos Verdes (northwest side), Point Vicente, White's Point, Emma-Eva Oil Platforms, Horseshoe Kelp, Huntington Beach, Fourteen Mile Bank, Laguna Beach, Dana Point, and Twin Harbor (Catalina); private boat sites were located near Venice Beach and the Los Angeles-Long Beach breakwater; piers sampled were Malibu, Santa Monica-Venice, Redondo, Cabrillo, Pier J, Belmont, and Newport.

Which fish were sampled?
Fish species were selected for sampling in the study based on several factors, the most important of which was the frequency of catch. Fish species sampled in the study were *Scorpaena guttata* (sculpin, scorpion fish, rattlesnake), *Scorpaenidae* (rockfish species, snappers), *Paralabrax nebulifer* (barred sand bass, sandy), *Paralabrax clathratus* (kelp bass, calico bass), *Sarda chiliensis* (pacific bonito, bonito), *Scomber japonicus* (pacific mackerel, blue mackerel), *Paralichthys californicus* (California halibut), *Citharichthys sordidus* (pacific sand dab), *Menticirrhus undulatus* (corbina), *Genyonemus lineatus* (white croaker, tom cod, kingfish), *Seriphus politus* (queenfish, herring), *Embiotocidae* (surfperch species, perch), *Sphyraena argentea* (California barracuda), *Girella nigricans* (opaleye, opaleye perch), *Medialuna californiensis* (halfmoon, Catalina blue perch, blue perch), and *Chielotrema saturnum* (black croaker, China croaker).

What pollutants were studied?
DHS began by conducting a pilot study to identify the chemical contaminants of concern for analysis in the comprehensive study. These chemicals are those which on the basis of their concentration in the fish tissues and their toxicity or cancer-causing properties showed the ability to contribute to potential health risks and required further study. This procedure for identifying chemicals for inclusion in the comprehensive study was needed because of the high cost of laboratory analyses and to determine where specialized analytical methods would be needed. Of more than 100 chemicals

- MORE -

analyzed for in the pilot study, PCBs and DDT were found to have a potential health risk. While some other toxic compounds were detected, their concentrations were not found to be sufficiently high to cause a health concern. PCBs and DDTs were therefore chosen for analysis in the comprehensive study. Both are carcinogenic in laboratory animals and suspected of causing cancer in humans.

Several other contaminants were also examined in the comprehensive study: chlordane, mercury, and tributyltin. Chlordane is another carcinogenic pesticide (like DDT) with wide domestic use and potential for contamination. Organic mercury is an organic metal which can cause nervous system damage, especially to the fetus. There were concerns that it might concentrate in higher trophic level fish species, that is, in fish higher up the food web. Tributyltin is mainly toxic to the immune system. It was included because it is the active ingredient of some anti-fouling paints applied to boat bottoms, and there was concern about its concentration in fish from marinas or other protected areas that get little flushing action. Tributyltin-containing paints were introduced relatively recently but were banned two years ago because of potential damage to shellfish.

What is the source of the contamination?

During the 1960s and 1970s, the discharge of industrial chemicals from the manufacturing of pesticides and other products contaminated ocean sediments along the coast of southern California. These contaminants were carried into the ocean primarily from sewage discharges, as well as from storm drains and river drainage, waste dumping from barges, and other unidentified sources. Several million pounds of DDT alone were estimated to have been deposited on the Palos Verdes Shelf from sewage outfalls. Pollution control strategies, such as pre-treatment of industrial wastewater, have greatly reduced these highly contaminated ocean discharges. The stable nature of chemicals such as DDT and polychlorinated biphenyls (PCBs) in the environment and their cancer causing potential, however, have led to continuing concerns about the health effects of consuming fish caught off this coastal area by sports anglers.

What is the risk of eating these fish?

If the consumption guidelines are followed, the theoretical excess cancer risk over a lifetime of consuming fish is, at most, 1 in 100,000 for DDT and 1 in 10,000 for PCB. The average lifetime risk of cancer from all causes is about one in four.

Consumption of seafood in the diet is strongly encouraged. Regular consumption of seafood is beneficial for most individuals and is a recommended part of the diet. Individuals should consume one to two meals per week of seafood. The consumption guidelines are not intended to undermine the recommendation to consume seafood. The specific advisory is in reference to the species of fish caught locally, and if the recommendations are followed, the benefits of consuming the seafood will most probably far exceed the potential risks caused by exposure to chemical contaminants.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

OEHHA

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

A STUDY OF CHEMICAL CONTAMINATION OF MARINE FISH FROM SOUTHERN CALIFORNIA

SUMMARY

II. COMPREHENSIVE STUDY

September 1991

EXECUTIVE SUMMARY

During the 1960s and 1970s, the discharge of industrial chemicals from the manufacturing of pesticides and other products contaminated ocean sediments along the coast of southern California. These contaminants were carried into the ocean from sewage and refinery discharges, storm drains and river drainage, waste dumping from barges, and other unidentified sources. Several million pounds of DDT alone were estimated to have been deposited on the Palos Verdes Shelf from sewage outfalls. The stable nature of chemicals such as DDT and polychlorinated biphenyls (PCBs) in the environment and their cancer causing potential have led to concerns about the health effects of consuming fish caught off this coastal area by sports anglers.

This report describes the results of a comprehensive study and health evaluation (risk assessment) of chemical contaminants in sports fish species in southern California. The study was conducted by the Office of Environmental Health Hazard Assessment (OEHHA) and its precursor organization in the California Department of Health Services (DHS), in cooperation with the California Department of Fish and Game, as required by Section 23 of Chapters 1,440 of the Statutes of 1985.

The purpose of the study was to collect a large number of fish species from representative locations in southern California, determine the concentrations of selected chemical contaminants in edible tissues, and evaluate the health significance of these levels so that specific guidelines for safe consumption of fish taken from this area could be developed.

Fish were collected from 24 sites in southern California, which represent areas fished by pier, private boat, and party boat anglers. A total of 15 different species of fish were sampled in the study, but not all 15 species were sampled at any one site. At each site five to ten different species of fish were sampled.

Generally, 20 fish of a single species were collected from each site. In addition, limited analyses of contaminant concentrations and fish size were conducted at seven sites (rockfishes and surfperches), and the effect of seasonal changes on contaminant concentrations was examined for white croaker at Cabrillo Pier. In total, nearly 4,000 fish were sampled in the study, and approximately 1,000 chemical analyses were performed on composite samples from the fish.

Selection of Contaminants, Species, and Sites

DHS began by conducting a pilot study to identify the chemical contaminants of concern for analysis in the comprehensive study. These chemicals are those which on the basis of their concentration in the fish tissues and their toxicity or cancer-causing properties showed the ability to contribute to potential health risks and required further study. This procedure for identifying chemicals for inclusion in the comprehensive study was needed because of the high cost of laboratory analyses and to determine where specialized analytical methods would be needed. Of more than 100 chemicals analyzed for in the pilot study, PCBs and DDT were found to have a potential health risk. While some other toxic compounds were detected, their concentrations were not found to be sufficiently high to cause a health concern. PCBs and DDTs were therefore chosen for analysis in the comprehensive study. Both are carcinogenic in laboratory animals and suspected of causing cancer in humans.

Several other contaminants were also examined in the comprehensive study: chlordane, mercury, and tributyltin. Chlordane is another carcinogenic pesticide (like DDT) with wide domestic use and potential for contamination. Organic mercury is an organic metal which can cause nervous system damage, especially to the fetus. There were concerns that it might concentrate in higher trophic level fish species, that is, in fish higher up the food web. Tributyltin is mainly toxic to the immune system. It was included because it is the active ingredient of some anti-fouling paints applied to boat bottoms, and there was concern about its concentration in fish from marinas or other protected areas that get little flushing action. Tributyltin-containing paints were introduced relatively recently but were banned two years ago because of potential damage to shellfish.

Fish species were selected for sampling in the study based on several factors, the most important of which was the frequency of catch. Fish species sampled in the study were sculpin (*Scorpaena guttata*), rockfish species (*Scorpaenidae*), barred sand bass (*Paralabrax nebulifer*), kelp bass (*Paralabrax clathratus*), pacific bonito (*Sarda chiliensis*), pacific mackerel (*Scomber japonicus*), California halibut (*Paralichthys californicus*), pacific sand dab (*Citharichthys sordidus*), corbina (*Menticirrhus undulatus*), white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), surfperch species (*Embiotocidae*), California barracuda (*Sphyraena argentea*), opaleye (*Girella nigricans*), halfmoon (*Medialuna californiensis*), and black croaker (*Chielotrema saturnum*).

Sampling sites were chosen after consultation with experts from DFG, EPA, consultants, and DHS. All collecting sites were frequently fished and were selected to represent the three types of fishing activities: pier, private, and party boat fishing.

Party and private boat sites sampled in the study were near Point Dume, Malibu, Marina del Rey, Short Bank, Redondo Beach, Palos Verdes (northwest side), Point Vicente, White's Point, Emma-Eva Oil Platforms, Horseshoe Kelp, Huntington Beach, Fourteen Mile Bank, Laguna Beach, Dana Point, and Twin Harbor (Catalina); private boat sites were located near Venice Beach and the Los Angeles-Long Beach breakwater; piers sampled were Malibu, Santa Monica-Venice, Redondo, Cabrillo, Pier J, Belmont, and Newport.

Study Methods and Results

Generally, 20 fish of each species were collected from each site. Composite samples for chemical analysis were prepared by combining a piece of edible tissue from 4 individual fish and, therefore, 5 analyses were conducted for each group of 20 fish. In all cases, the tissue samples taken from these fish represented edible muscle tissue. Tissue concentrations of total DDT and its metabolites (DDE and DDD), chlordanes, and PCBs were determined in all sampled tissues. In addition, 100 composite samples were analyzed for mercury levels, and a single sampling of white croaker from Marina del Rey (20 fish; 5 composite analyses) was analyzed for levels of tributyltin. A comprehensive quality assurance/quality control (QA/QC) program was also conducted as part of this study.

Total DDT (sum of DDT, DDE and DDD concentrations) detected in individual composite samples of the fish tissues (not the average levels) ranged from non-detectable to as high as 8,052 parts per billion (ppb) wet weight at Cabrillo Pier in white croaker. Chlordane levels (sum of cis- and trans-chlordane and trans-nonachlor) were usually non-detectable to as high as 65 ppb (wet wt.) for a composite sample of small surfperches from Pier J. PCBs (sum of aroclors 1,254 and 1,260) were frequently non-detectable, and the highest level was 3,539 ppb (wet wt.) in a sample of white croaker from Malibu. Mercury levels ranged from below 50 ppb to 724 ppb (wet wt.) in rockfishes from White's Point. Tributyltin levels ranged from 52 to 105 ppb (wet wt.) in the five composites of white croaker collected within the Marina del Rey.

Numerous statistically significant differences in mean (geometric) contaminant levels between sites were found for several fish species. Generally, the most contaminated sites appeared to be those off the Palos Verdes Peninsula and around the Los Angeles-Long Beach Harbors.

In general, the white croaker, which is a bottom-feeding species, was the most contaminated fish species at a site, especially if the site was highly contaminated. Other relatively contaminated species were corbina, queenfish, surfperches, and sculpin. Bonito, mackerel, halibut, sand dab, barracuda, opaleye, and halfmoon usually had the lowest levels of contaminants, although in some cases only a few sites were sampled for these species (e.g., for opaleye, halfmoon, barracuda, and sand dab).

Health Risks

For the three carcinogenic contaminants in the study, DDTs, PCBs, and chlordane, the potential theoretical excess cancer risks from consumption of the fish species were estimated for all samples in which contaminant concentrations were above the method detection limits (MDL) of the study (38 ppb for DDTs, 50 ppb for PCBs, and 3 ppb for chlordane). Theoretical risks were estimated for a lifetime using an exposure equal to consuming one meal per week of the species from the site (23 grams/day; equivalent to a 5 3/4 ounce meal per week). These risks ranged from 4.4 excess cases of cancer in a population of one million (4.4×10^{-6}) to 3 in 1,000 (3.0×10^{-3}).

(It should be noted that the theoretical excess cancer risk for PCBs at the MDL [50 ppb] is 1×10^{-4} and, therefore, all positive detections of PCBs result in an estimated risk above 1×10^{-4}.)

Chlordane levels were low in most samples and only occasionally exceeded the MDL. Overall, chlordane did not contribute significantly to a cancer risk in any of the species and locations sampled. Neither methylmercury nor tributyltin were found to occur at levels of significant health concern. It is recommended that the State Mussel Watch program continue to collect data on tributyltin levels, however, to make sure that they are continuing to decline.

Development of Consumption Guidelines

In order to provide useful guidance to anglers and consumers based on findings from this complex study, consumption recommendations were developed using "trigger" levels in the fish species. Recommendations are provided for species and sites which exceeded 100 ppb of either total DDTs or PCBs or 23 ppb of total chlordane. The trigger levels for total DDTs and chlordanes are based on excess cancer risks of about 1 in 100,000 (1×10^{-5}). The above-mentioned problem with the MDL for PCBs, however, prevented setting a conservative health-based level for PCBs, since the risk at the MDL is 1×10^{-4}. The trigger levels were developed specific to this study, therefore, and should not be used in deriving standards.

Consumption recommendations are provided by fish species and by specific geographic site. In addition, general consumption recommendations are provided.

The QA/QC program established that the analyses were adequate, but also noted a negative bias in the data from the contract laboratory. Overall, data from the QA/QC laboratory (Hazardous Materials Laboratory, California Department of Health Services) were about three times higher than the levels reported by the contract laboratory (Pacific Analytical, Incorporated). The sources of this bias were not resolved, but the differences are considered and accounted for in the interpretation of the data and the development of the final recommendations.

Uncertainties in the risk assessment involve the usual orders of magnitude in uncertainties associated with the hazard identification and dose-response methodologies in risk assessment. The standard approach in deriving a carcinogenic potency factor (CPF) involves extrapolating data from laboratory animals to humans, and the resulting CPF is derived so that it does not likely underestimate risk. Therefore, use of the CPF may overestimate actual risks, and real risks are likely to be lower.

Uncertainties involved in the exposure assessment include the use of consumption estimates and the chemical concentrations in the fish tissues. Accurate consumption data are not available, but 23 grams/day is in the range of reported values for consumption by sport anglers. In addition, the negative bias noted above in the analytical data indicates that actual levels may be higher. On the other hand, consumption of other (less contaminated) species would lower the risks. It was concluded that the uncertainty in the exposure assessment ranged from an underestimate of up to 15 times to an overestimate of 17 times.

Guidance for consumption of fish caught within the study area are summarized below. Recommendations are provided for specific sampling sites and for specific fish species sampled in the study. In addition, general fish consumption guidance is provided.

General Dietary Recommendations

OEHHA strongly encourages consumption of seafood in the diet as a general recommendation. Regular consumption of seafood is beneficial for most individuals and is a recommended part of the diet. Individuals should consume one to two meals per week of seafood. The specific guidance which follows is not intended to undermine the recommendation to consume seafood. The specific advisory is in reference to the species of fish caught locally, and if the recommendations are followed, the benefits of consuming the seafood will most probably far exceed the potential risks caused by exposure to chemical contaminants.

OEHHA also provides the following general consumption guidelines to anglers which, in general, will result in decreased overall health risks resulting from consumption of chemically contaminated seafood. OEHHA recommends that, in addition to the specific guidelines, these general guidelines be followed:

1. Eat a variety of different fish species. In this way, exposure to chemical contaminants is reduced in comparison to consumption of only a highly contaminated species.

2. Consume fish caught from several different fishing locations. In this way, overall exposure to chemical contaminants is reduced in comparison to exposure to highly contaminated fish species from highly contaminated sites. In addition, avoid exclusively fishing in the more highly contaminated areas including White's Point, the Los Angeles-Long Beach Harbors, and Horseshoe Kelp.

3. Trim fat from fish fillets and cook fish by baking or broiling on a rack to reduce DDTs and PCBs in the edible portion (DDTs and PCBs tend to concentrate in the fatty tissues of fish). This method of preparation will not reduce concentrations of all chemical contaminants (e.g., metals).

Site-Specific Recommendations

The following recommendations provide guidance for specific fishing locations and species. Anglers may use these recommendations as an indication of how often to fish in an area and/or how often to eat a specific fish species caught at a site. These recommendations should be used with the general recommendations given above. Details on each site and the criteria for establishing the site-specific recommendations are presented in the body of the report.

SITE-SPECIFIC CONSUMPTION RECOMMENDATIONS

SITE	FISH SPECIES	RECOMMENDATION*
Marina del Rey Huntington Beach Fourteen Mile Bank Laguna Beach Redondo Beach Emma/Eva oil platforms Catalina (Twin Harbor) Santa Monica Pier Venice Pier Venice Beach Dana Point	All species	No restrictions
Newport Pier Redondo Pier Belmont Pier Pier J	Corbina • Surfperches •	One meal every two weeks
Malibu Pier	Queenfish	One meal a month
Short Bank	White croaker	One meal every two weeks
Malibu Point Dume	White croaker •	Do not consume
Point Vicente Palos Verdes - Northwest	White croaker •	Do not consume
White's Point	White croaker	Do not consume
	Sculpin Rockfishes Kelp bass	One meal every two weeks+
Los Angeles/Long Beach Harbors (esp. Cabrillo Pier)	White croaker	Do not consume
	Queenfish Black croaker Surfperches	One meal every two weeks+
Los Angeles/Long Beach Breakwater (ocean side)	White croaker Queenfish Surfperches Black croaker	One meal a month+
Horseshoe Kelp	Sculpin White croaker	One meal a month+

* One meal is about six ounces.

+ Consumption recommendation is for all the listed species combined.

Species-Specific Recommendations

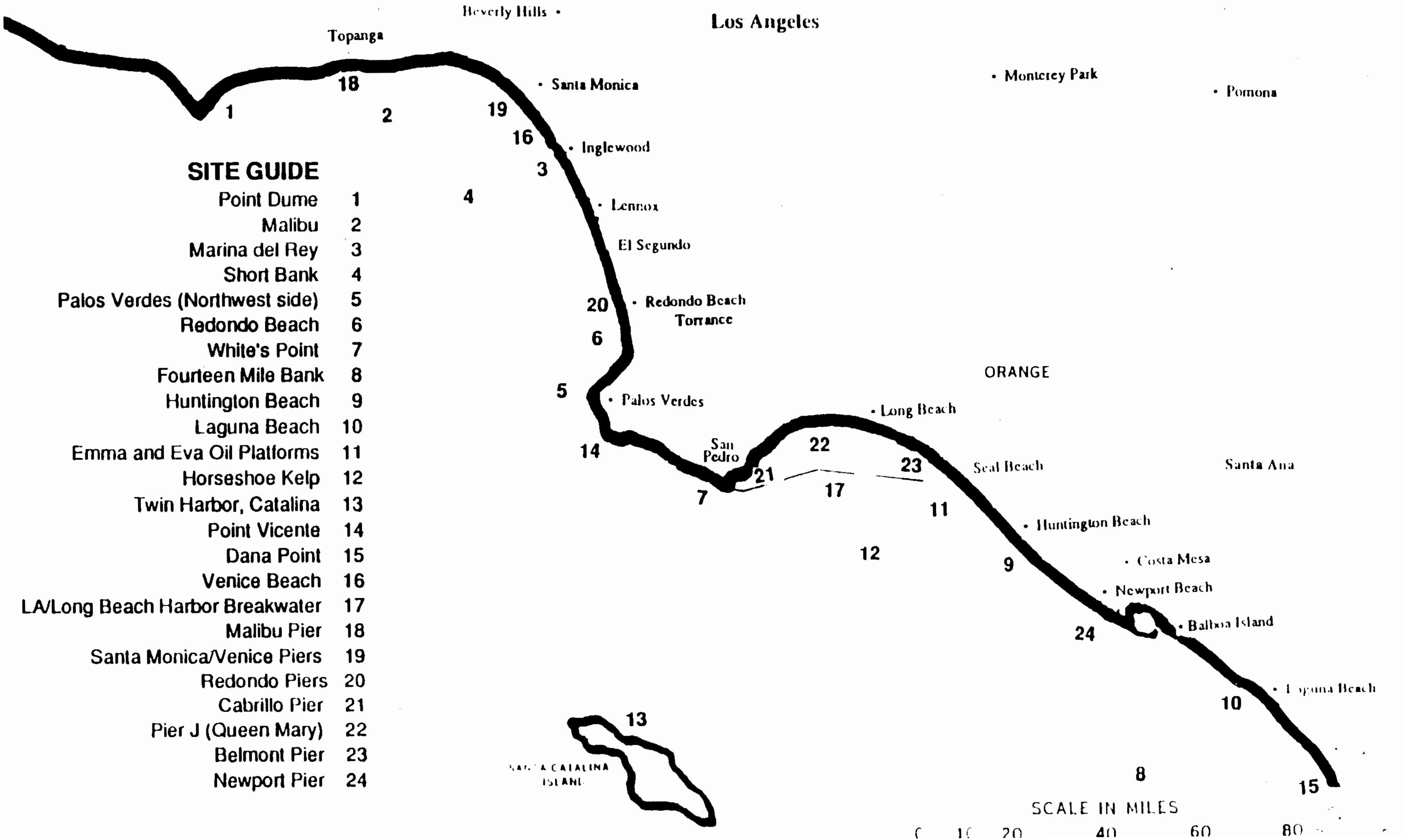
For the purpose of providing fish consumption guidance based only on a comparison of fish species in the entire study area, the following groups were formed:

SPECIES-SPECIFIC CONSUMPTION RECOMMENDATIONS

FISH SPECIES	CONTAMINATION GROUP	RECOMMENDATION*
White croaker	HIGH	Avoid consumption
Corbina Queenfish Surfperches Sculpin	MODERATE	Consume not more than one meal every two weeks
Black croaker Barred sand bass Rock fishes Kelp bass	LOW	Consumption not restricted
Bonito Mackerel Sand dab Barracuda Opaleye Halfmoon Halibut	LOWEST	Consumption not restricted

* One meal is about six ounces.

MAP OF SITES SAMPLED IN THE COMPREHENSIVE STUDY OF SOUTHERN CALIFORNIA



SITE GUIDE

Point Dume	1
Malibu	2
Marina del Rey	3
Short Bank	4
Palos Verdes (Northwest side)	5
Redondo Beach	6
White's Point	7
Fourteen Mile Bank	8
Huntington Beach	9
Laguna Beach	10
Emma and Eva Oil Platforms	11
Horseshoe Kelp	12
Twin Harbor, Catalina	13
Point Vicente	14
Dana Point	15
Venice Beach	16
LA/Long Beach Harbor Breakwater	17
Malibu Pier	18
Santa Monica/Venice Piers	19
Redondo Piers	20
Cabrillo Pier	21
Pier J (Queen Mary)	22
Belmont Pier	23
Newport Pier	24

How to obtain copies of A Study of Chemical Contamination of Marine Fish from Southern California

Complete copies of *A Study of Chemical Contamination of Marine Fish from Southern California, II. Comprehensive Study* are being distributed to public libraries in Los Angeles and Orange Counties, as well as to selected state depository libraries. They may also be obtained as follows:

Copies of the summary report are available free by writing or calling (Single copy requests only, please):

California Environmental Protection Agency
Office of Environmental Health Hazard Assessment
Pesticide and Environmental Toxicology Section
2151 Berkeley Way
Berkeley, CA 94704
(510) 540-3063

Copies of the complete study may be ordered from Copies Unlimited, 5904 Sunset Blvd, Los Angeles, CA 90028, (213) 462-5532 or 462-5688. The price is $14.00, plus tax and postage, for a loose-leaf, three hole punch copy. Call for information on other options (bindings, bulk discounts, etc.).

STATE OF CALIFORNIA

O E H H A

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

SEPTEMBER 1991

A STUDY OF CHEMICAL CONTAMINATION OF MARINE FISH FROM SOUTHERN CALIFORNIA

II. COMPREHENSIVE STUDY

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A STUDY OF CHEMICAL CONTAMINATION OF MARINE FISH
FROM SOUTHERN CALIFORNIA

II. COMPREHENSIVE STUDY

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PREFACE

This report describes the results of a comprehensive study on fish sampling and chemical analysis conducted by the Office of Environmental Health Hazard Assessment (OEHHA) and its precursor organization in the Department of Health Services (DHS) to measure levels of chemical contaminants in edible tissues from fish collected in southern California. The study was in response to Section 23 of Chapter 1440 Statutes of 1985, which appropriated funds to the DHS "... for a one-time study, with the cooperation of the Department of Fish and Game, of marine pollution monitoring and health risk assessment."

In 1985, DHS evaluated the potential health effects from eating chemically contaminated sportfish (mainly white croaker) taken from southern California and, based on available data, concluded that the cancer risks from frequent consumption of the fish were excessive. As a result of this finding, DHS issued an interim health advisory warning against consumption of white croaker and other sportfish species in selected areas of southern California (Appendix B-I). The advisory was interim because the data upon which it was based were not considered adequate for a thorough health evaluation; the data were not recent and were only for one species of fish. DHS recommended that additional data be collected for a more complete evaluation.

To carry out this recommendation and to enable the Department to investigate the health effects of eating contaminated marine fish, the

Director of DHS convened an interagency task force (Appendix B-II). The task force was charged to:

1. Collate and analyze available information on fish contamination in California's fresh and marine waters.

2. Identify ways to optimize the coordination of activities of relevant agencies dealing with the chemical contamination of fish.

3. Propose possible solutions to problems relating to the chemical contamination of fish.

In cooperation with staff from the California Department of Fish and Game (DFG), the U. S. Environmental Protection Agency (EPA), and Tetra Tech., Inc. (consultation funded by EPA), DHS developed a generic study plan which was approved by the task force in 1985 (Appendix B-III). This study plan also included a more detailed description of a study focused on chemically contaminated sportfish in southern California.

Later, two coastal waters were selected for study and comparison: (1) the waters of southern California, around the Los Angeles area, and (2) Monterey Bay. A pilot study involving fish collected from the southern California area was conducted for the purpose of identifying chemicals of concern to human health in edible tissues of sportfish. Chemicals of concern are those chemical contaminants found in fish tissues at concentrations which suggest a potential health threat and these are considered for further evaluation in a comprehensive study. Fish species suspected of being the most highly contaminated were collected, and their tissues (liver and muscle) analyzed for a wide range of potential chemical contaminants. The results of this pilot study were described in a previous report (DHS, 1991).

The second study, the comprehensive study, followed the pilot study and is the subject of this report. In the comprehensive study, many frequently caught fish species were sampled at 24 locations to determine the concentrations in edible muscle tissue of the chemicals of concern identified in the pilot study. The comprehensive study was designed to provide an extensive database with the objective to perform a thorough health evaluation.

The third study is an epidemiological study of fish consumption and chemical contaminants in breastmilk. This study, which is currently in progress, involves 160 lactating women residing in the Los Angeles area, who provided breastmilk samples for chemical analysis and a history of fish consumption. This study will be completed in 1991.

The fourth study in southern California is a small investigation of the extent of chemical contamination of commercial fish in southern California. The purpose of the study is to survey and summarize available literature to provide sufficient data to design a study of the commercial market. Although concerns have been expressed regarding levels of chemical contaminants in commercial fish, we lacked adequate information to design a scientifically valid study to evaluate the situation. OEHHA'S view is that the commercial study will provide sufficient information to design a study of chemical contaminants in commercial fish. This is only a literature investigation and no samples were collected and analyzed for this study (report in preparation).

The fifth study is of chemical contaminants in fish conducted in the Monterey Bay area (report in preparation). The study was contracted to DFG, and sub-contracted to the University of California at Santa Cruz. The study included an initial pilot study which was followed by a comprehensive study.

The studies conducted by OEHHA and DHS and described above aim to provide adequate data to perform comprehensive health evaluations and risk assessments, and provide useful public health guidance. The studies will serve as models for future studies by OEHHA and the results will guide the design of such studies. The information gathered and knowledge gained in these studies will assist in the future design and conduct of simpler and less expensive studies of other contaminated or potentially contaminated waters of the State that are of public health significance.

ACKNOWLEDGEMENTS

This report represents part of an original study design prepared by technical staff of the Office of Environmental Health Hazard Assessment (OEHHA) and its precursor organization in the Department of Health Services (DHS), Department of Fish and Game, Environmental Protection Agency, and Tetra Tech, Incorporated. The study design was then reviewed and revised by members of the Director's task force to address human health issues related to chemical contamination of fish. OEHHA recognizes the efforts of those scientists involved in the original study design and the members of the task force for their valuable contributions.

OEHHA also recognizes the efforts and cooperation of Pacific Analytical, Incorporated and Southern California Coastal Water Research Project for their roles in conducting parts of the study.

We also thank the following reviewers of the draft reports: Dr. Brian Melzian of the Environmental Protection Agency, Messrs. Tom Lew and Pete Phillips of the Department of Fish and Game, and Mr. Craig Wilson of the State Water Resources Control Board. The report was also reviewed by Drs. Richard Ames, Steven Book, and Richard Jackson of OEHHA.

We also thank Mses. Patricia Henry, Sharon Davis, and Shirley Higgins for their diligence in the preparation of the text and tables contained in this report.

TABLE OF CONTENTS

PREFACE i
ACKNOWLEDGEMENTS v
TABLE OF CONTENTS vi
LIST OF FIGURES xiii
LIST OF TABLES xiii
EXECUTIVE SUMMARY xix

I. INTRODUCTION 1

I.A. Historical Background 1
I.B. Department of Health Services' (DHS) Activities 2
I.C. Study Rationale 3
I.D. Pilot Study 4
I.E. Comprehensive Study 5

I.E.1. Species Selection 5
I.E.2. Site Selection 6

I.F. Contract Implementation 7

I.F.1. Request for Proposals (RFP) 8

II. MATERIALS AND METHODS 9

II.A. Fish Collection 9
II.B. Sampling Sites 10
II.C. Sample Dissection, Resection, and Compositing 11
II.D. Sample Preparation and Extraction 12

II.D.1 DDTs, Chlordane, PCBs, and Lipid 12
II.D.2. Gas-Liquid Chromatography 13
II.D.3. Quantitation of Chlordane 13
II.D.4. Quantitation of PCBs 14
II.D.5. Mercury Determination 14
II.D.6. Tributyltin Determination 14

II.E. Method Detection Limit (MDL) Determination 15

II.F. Quality Assurance/Quality Control (QA/QC) 15

II.F.1. General 15
II.F.2. Mercury QA/QC 17

II.G. Statistical Analysis 17

II.G.1 Analysis of Variance Procedure 19
II.G.2. Size Analysis 20
II.G.3. Values Below the MDL 20

III. RESULTS 27

III.A. Fish collection 27
III.B. Tissue Concentrations of DDTs and PCBs 28

III.B.1. Fish Species 28

III.B.1.a. Sculpin 28
III.B.1.b. Rockfishes 30
III.B.1.c. Barred Sand Bass 30
III.B.1.d. Kelp Bass 31
III.B.1.e. Pacific Bonito 32
III.B.1.f. Pacific Mackerel 33
III.B.1.g. California Halibut 33
III.B.1.h. Pacific Sand Dab 34
III.B.1.i. Corbina 34
III.B.1.j. White Croaker 35
III.B.1.k. Queenfish 37
III.B.1.l. Surfperches 38
III.B.1.m. Barracuda, Opaleye, And Halfmoon 39
III.B.1.n. Black Croaker 39

III.B.2. Size Analysis 40

III.B.2.a. Surfperches 41
III.B.2.b. Rockfishes 42

III.B.3. Seasonal Analysis 43

III.C. Chlordane Results 43
III.D. Mercury Results 44
III.E. TBT Analyses 44
III.F. Method Detection Limits (MDL) 44
III.G. Quality Assurance/Quality Control 45
III.H. Mercury QA/QC 45

IV. DISCUSSION 71

IV.A. Site Differences by Species 71

IV.A.1. Sculpin 71
IV.A.2. Rockfishes 72
IV.A.3. Barred Sand Bass 73
IV.A.4. Kelp Bass 74
IV.A.5. Pacific Bonito 74
IV.A.6. Pacific Mackerel 75
IV.A.7. California Halibut 75
IV.A.8. Pacific Sand Dab 76
IV.A.9. Corbina 76
IV.A.10. White Croaker 77
IV.A.11. Queenfish 79
IV.A.12. Surfperches 80
IV.A.13. California Barracuda. Opaleye, and Halfmoon 81
IV.A.14. Black Croaker 81

IV.B. Size Versus Chemical Concentration Analysis 82

IV.B.1. Surfperches 82
IV.B.2. Rockfishes 82

IV.C. Seasonal Analysis 83
IV.D. Chlordane 83
IV.E. Methylmercury 84
IV.F. TBT 86
IV.G. Overall Observations 86
IV.H. QA/QC Program 88

V. HEALTH EVALUATION 92

V.A. Risk Assessment 92

V.A.1. Hazard Identification 92

V.A.1.a. DDT and PCBs 92
V.A.1.b. Chlordane 94
V.A.1.c. Methylmercury 95
V.A.1.d. TBT 96

V.A.2. Dose-Response Assessment 97

V.A.2.a. DDTs 97
V.A.2.b. PCBs 97
V.A.2.c. Chlordane 97
V.A.2.d. Methylmercury 98
V.A.2.e. TBT 98

V.A.3. Exposure Assessment 98

V.A.3.a. General Scenario 98
V.A.3.b. Creel Scenario 100
V.A.3.c. Seasonally Adjusted Consumption Scenarios 102

V.A.4. Risk Characterization 104

V.A.4.a. DDT and PCBs 104

V.A.4.a.(1). General Scenario 104
V.A.4.a.(2). Creel Scenario 106
V.A.4.a.(3). Seasonal Scenario 106

V.A.4.b. Chlordane 107
V.A.4.c. Methylmercury 107
V.A.4.d. TBT 108

V.A.5. Assumptions and Uncertainties 108

V.A.5.a. Hazard Identification and Dose-Response 108

V.A.5.a.(1). DDTs, Chlordane, and PCBs 108
V.A.5.a.(2). Methylmercury 109
V.A.5.a.(3). TBT 109

V.A.5.b. Exposure Assessment 109

V.A.5.b.(1). Tissue Concentrations 110
V.A.5.b.(2). Consumption Rate 110
V.A.5.b.(3). Duration of Consumption 112

V.A.5.c. Summary 112

V.B. Recommendations 134

V.B.1. Alternative Approaches for Guidance Development 134

V.B.1.a. Conservative Consumption Scenario 134
V.B.1.b. Creel Consumption Scenario 135
V.B.1.c. Trigger Levels 135

V.B.1.c.(1) DDTs 135
V.B.1.c.(2) PCBs 136
V.B.1.c.(3) Conclusions on DDTs and PCBs 139

V.B.1.d. Chlordane 139
V.B.1.e. Methylmercury 139
V.B.1.f. TBT 140

V.B.2. General Criteria and Recommendations for Fish Consumption 140

V.B.2.a. Criteria for Recommendations 140
V.B.2.b. General Dietary Recommendations 142

V.B.3. Species-Specific Criteria and Recommendations 142

V.B.3.a. Criteria for Recommendations 142
V.B.3.b. Species-Specific Recommendations 144

V.B.4. Site-Specific Criteria and Recommendations 145

V.B.4.a. Criteria for Recommendations 145

V.B.4.a.(1). Dana Point 147
V.B.4.a.(2). Malibu 147

V.B.4.b. Site-Specific Consumption Recommendations 148

V.B.4.b.(1). Marina del Rey, Huntington Beach, Fourteen Mile Bank, Laguna Beach, Redondo Beach, Emma/Eva Oil Platforms, Catalina (Twin Harbor), Santa Monica Venice Piers, and Venice Beach 148

V.B.4.b.(2). Newport Pier, Belmont Pier, Redondo Piers, and Pier J 148

V.B.4.b.(3). Malibu Pier 148

V.B.4.b.(4). Short Bank 148

V.B.4.b.(5). Malibu and Point Dume 148

V.B.4.b.(6). Palos Verdes/Northwest and Point Vicente 149

V.B.4.b.(7). White's Point, Los Angeles/Long Beach Harbor Breakwater, Los Angeles/Long Beach Harbor Sites (especially Cabrillo Pier), and Horseshoe Kelp ... 149

V.B.4.b.(7a). White's Point 149

V.B.4.b.(7b). Los Angeles/Long Beach Harbors (especially Cabrillo Pier) 149

V.B.4.b.(7c). Los Angeles/Long Beach Breakwater 150

V.B.4.b.(7d). Horseshoe Kelp 150

V.B.5. Other General Recommendations 152

VI. REFERENCES 157

EXECUTIVE SUMMARY

During the 1960s and 1970s, the discharge of industrial chemicals from the manufacturing of pesticides and other products contaminated ocean sediments along the coast of southern California. These contaminants were carried into the ocean from sewage and refinery discharges, storm drains and river drainage, waste dumping from barges, and other unidentified sources. Several million pounds of DDT alone were estimated to have been deposited on the Palos Verdes Shelf from sewage outfalls. The stable nature of chemicals such as DDT and polychlorinated biphenyls (PCBs) in the environment and their cancer causing potential have led to concerns about the health effects of consuming fish caught off this coastal area by sports anglers.

This report describes the results of a comprehensive study and health evaluation (risk assessment) of chemical contaminants in sports fish species in southern California. The study was conducted by the Office of Environmental Health Hazard Assessment (OEHHA) and its precursor organization in the California Department of Health Services (DHS), in cooperation with the California Department of Fish and Game, as required by Section 23 of Chapters 1440 of the Statutes of 1985.

The purpose of the study was to collect a large number of fish species from representative locations in southern California, determine the concentrations of selected chemical contaminants in edible tissues, and evaluate the health significance of these levels so that specific guidelines for safe consumption of fish taken from this area could be developed.

Fish were collected from 24 sites in southern California, which represent areas fished by pier, private boat, and party boat anglers. A total of 15 different species of fish were sampled in the study, but not all 15 species were sampled at any one site. At each site 5 to 10 different species of fish were sampled.

Generally, 20 fish of a single species were collected from each site. In addition, limited analyses of contaminant concentrations and fish size were conducted at seven sites (rockfishes and surfperches), and the effect of seasonal changes on contaminant concentrations was examined for white croaker at Cabrillo Pier. In total, nearly 4000 fish were sampled in the study, and approximately 1000 chemical analyses were performed on composite samples from the fish.

Selection of Contaminants, Species, and Sites

DHS began by conducting a pilot study to identify the chemical contaminants of concern for analysis in the comprehensive study. These chemicals are those which on the basis of their concentration in the fish tissues and their toxicity or cancer-causing properties showed the ability to contribute to potential health risks and required further study. This procedure for identifying chemicals for inclusion in the comprehensive study was needed because of the high cost of laboratory analyses and to determine where specialized analytical methods would be needed. Of more than 100 chemicals analyzed for in the pilot study, PCBs and DDT were found to have a potential health risk. While some other toxic compounds were detected, their concentrations were not found to be sufficiently high to cause a health concern. PCBs and DDTs were therefore chosen for analysis in the comprehensive study. Both are carcinogenic in laboratory animals and suspected of causing cancer in humans.

Several other contaminants were also examined in the comprehensive study: chlordane, mercury, and tributyltin. Chlordane is another carcinogenic pesticide (like DDT) with wide domestic use and potential for contamination. Organic mercury is an organic metal which can cause nervous system damage, especially to the fetus. There were concerns that it might concentrate in higher trophic level fish species, that is, in fish higher up the food web. Tributyltin is mainly toxic to the immune system. It was included because it is the active ingredient of some anti-fouling paints applied to boat bottoms, and there was concern about its concentration in fish from marinas or other protected areas that get little flushing action. Tributyltin-containing paints were introduced relatively recently but were banned two years ago because of potential damage to shellfish.

Fish species were selected for sampling in the study based on several factors, the most important of which was the frequency of catch. Fish species sampled in the study were sculpin (*Scorpaena guttata*), rockfish species (*Scorpaenidae*), barred sand bass (*Paralabrax nebulifer*), kelp bass (*Paralabrax clathratus*), pacific bonito (*Sarda chiliensis*), pacific mackerel (*Scomber japonicus*), California halibut (*Paralichthys californicus*), pacific sand dab (*Citharichthys sordidus*), corbina (*Menticirrhus undulatus*), white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), surfperch species (*Embiotocidae*), California barracuda (*Sphyraena argentea*), opaleye (*Girella nigricans*), halfmoon (*Medialuna californiensis*), and black croaker (*Chielotrema saturnum*).

Sampling sites were chosen after consultation with experts from DFG, EPA, consultants, and DHS. All collecting sites were frequently fished and were selected to represent the three types of fishing activities: pier, private, and party boat fishing.

Party and private boat sites sampled in the study were near Point Dume, Malibu, Marina del Rey, Short Bank, Redondo Beach, Palos Verdes (northwest side), Point Vicente, White's Point, Emma-Eva Oil Platforms, Horseshoe Kelp, Huntington Beach, Fourteen Mile Bank, Laguna Beach, Dana Point, and Twin Harbor (Catalina); private boat sites were located near Venice Beach and the Los Angeles-Long Beach breakwater; piers sampled were Malibu, Santa Monica-Venice, Redondo, Cabrillo, Pier J, Belmont, and Newport.

Study Methods and Results

Generally, 20 fish of each species were collected from each site. Composite samples for chemical analysis were prepared by combining a piece of edible tissue from 4 individual fish and, therefore, 5 analyses were conducted for each group of 20 fish. In all cases, the tissue samples taken from these fish represented edible muscle tissue. Tissue concentrations of total DDT and its metabolites (DDE and DDD), chlordanes, and PCBs were determined in all sampled tissues. In addition, 100 composite samples were analyzed for mercury levels, and a single sampling of white croaker from Marina del Rey (20 fish; 5 composite analyses) was analyzed for levels of tributyltin. A comprehensive quality assurance/quality control (QA/QC) program was also conducted as part of this study.

Total DDT (sum of DDT, DDE and DDD concentrations) detected in individual composite samples of the fish tissues (not the average levels) ranged from non-detectable to as high as 8052 parts per billion (ppb) wet weight at Cabrillo Pier in white croaker. Chlordane levels (sum of cis- and trans-chlordane and trans-nonachlor) were usually non-detectable to as high as 65 ppb (wet wt.) for a composite sample of small surfperches from Pier J. PCBs (sum of aroclors 1254 and 1260) were frequently non-detectable, and the highest level was 3539 ppb (wet wt.) in a sample of white croaker from Malibu. Mercury levels ranged from below 50 ppb to 724 ppb (wet wt.) in rockfishes from White's Point. Tributyltin levels ranged from 52 to 105 ppb (wet wt.) in the five composites of white croaker collected within the Marina del Rey.

Numerous statistically significant differences in mean (geometric) contaminant levels between sites were found for several fish species. Generally, the most contaminated sites appeared to be those off the Palos Verdes Peninsula and around the Los Angeles-Long Beach Harbors.

In general, the white croaker, which is a bottom-feeding species, was the most contaminated fish species at a site, especially if the site was highly contaminated. Other relatively contaminated species were corbina, queenfish, surfperches, and sculpin. Bonito, mackerel, halibut, sand dab, barracuda, opaleye, and halfmoon usually had the lowest levels of contaminants, although in some cases only a few sites were sampled for these species (e.g., for opaleye, halfmoon, barracuda, and sand dab).

Health Risks

For the three carcinogenic contaminants in the study, DDTs, PCBs, and chlordane, the potential theoretical excess cancer risks from consumption of the fish species were estimated for all samples in which contaminant concentrations were above the method detection limits (MDL) of the study (38 ppb for DDTs, 50 ppb for PCBs, and 3 ppb for chlordane). Theoretical risks were estimated for a lifetime using an exposure equal to consuming one meal per week of the species from the site (23 grams/day; equivalent to a 5 3/4 ounce meal per week). These risks ranged from 4.4 excess cases of cancer in a population of one million (4.4×10^{-6}) to 3 in 1,000 (3.0×10^{-3}).

(It should be noted that the theoretical excess cancer risk for PCBs at the MDL [50 ppb] is 1×10^{-4} and, therefore, all positive detections of PCBs result in an estimated risk above 1×10^{-4}.)

Chlordane levels were low in most samples and only occasionally exceeded the MDL. Overall, chlordane did not contribute significantly to a cancer risk in any of the species and locations sampled. Neither methylmercury nor tributyltin were found to occur at levels of significant health concern. It is recommended that the State Mussel Watch program continue to collect data on tributyltin levels, however, to make sure that they are continuing to decline.

Development of Consumption Guidelines

In order to provide useful guidance to anglers and consumers based on findings from this complex study, consumption recommendations were developed using "trigger" levels in the fish species. Recommendations are provided for species and sites which exceeded 100 ppb of either total DDTs or PCBs or 23 ppb of total chlordane. The trigger levels for total DDTs and chlordanes are based on excess cancer risks of about 1 in 100,000 (1×10^{-5}). The above-mentioned problem with the MDL for PCBs, however, prevented setting a conservative health-based level for PCBs, since the risk at the MDL is 1×10^{-4}. The trigger levels were developed specific to this study, therefore, and should not be used in deriving standards.

Consumption recommendations are provided by fish species and by specific geographic site. In addition, general consumption recommendations are provided.

The QA/QC program established that the analyses were adequate, but also noted a negative bias in the data from the contract laboratory. Overall, data from the QA/QC laboratory (Hazardous Materials Laboratory, California Department of Health Services) were about three times higher than the levels reported by the contract laboratory (Pacific Analytical, Incorporated). The sources of this bias were not resolved, but the differences are considered and accounted for in the interpretation of the data and the development of the final recommendations.

Uncertainties in the risk assessment involve the usual orders of magnitude in uncertainties associated with the hazard identification and dose-response methodologies in risk assessment. The standard approach in deriving a carcinogenic potency factor (CPF) involves extrapolating data from laboratory animals to humans, and the resulting CPF is derived so that it does not likely underestimate risk. Therefore, use of the CPF may overestimate actual risks, and real risks are likely to be lower.

Uncertainties involved in the exposure assessment include the use of consumption estimates and the chemical concentrations in the fish tissues. Accurate consumption data are not available, but 23 grams/day is in the range of reported values for consumption by sport anglers. In addition, the negative bias noted above in the analytical data indicates that actual levels may be higher. On the other hand, consumption of other (less contaminated) species would lower the risks. It was concluded that the uncertainty in the exposure assessment ranged from an underestimate of up to 15 times to an overestimate of 17 times.

Guidance for consumption of fish caught within the study area are summarized below. Recommendations are provided for specific sampling sites and for specific fish species sampled in the study. In addition, general fish consumption guidance is provided.

General Dietary Recommendations

OEHHA strongly encourages consumption of seafood in the diet as a general recommendation. Regular consumption of seafood is beneficial for most individuals and is a recommended part of the diet. Individuals should consume one to two meals per week of seafood. The specific guidance which follows is not intended to undermine the recommendation to consume seafood. The specific advisory is in reference to the species of fish caught locally, and if the recommendations are followed, the benefits of consuming the seafood will most probably far exceed the potential risks caused by exposure to chemical contaminants.

OEHHA also provides the following general consumption guidelines to anglers which, in general, will result in decreased overall health risks resulting from consumption of chemically contaminated seafood. OEHHA recommends that, in addition to the specific guidelines, these general guidelines be followed:

1. Eat a variety of different fish species. In this way, exposure to chemical contaminants is reduced in comparison to consumption of only a highly contaminated species.

2. Consume fish caught from several different fishing locations. In this way, overall exposure to chemical contaminants is reduced in comparison to exposure to highly contaminated fish species from highly contaminated sites. In addition, avoid exclusively fishing in the more highly contaminated areas including White's Point, the Los Angeles-Long Beach Harbors, and Horseshoe Kelp.

3. Trim fat from fish fillets and cook fish by baking or broiling on a rack to reduce DDTs and PCBs in the edible portion (DDTs and PCBs tend to concentrate in the fatty tissues of fish). This method of preparation will not reduce concentrations of all chemical contaminants (e.g., metals).

Site-Specific Recommendations

The following recommendations provide guidance for specific fishing locations and species. Anglers may use these recommendations as an indication of how often to fish in an area and/or how often to eat a specific fish species caught at a site. These recommendations should be used with the general recommendations given above. Details on each site and the criteria for establishing the site-specific recommendations are presented in the body of the report.

SITE-SPECIFIC CONSUMPTION RECOMMEN[illegible]ONS

SITE	FISH SPECIES	RECOMMENDATION*
Marina del Rey Huntington Beach Fourteen Mile Bank Laguna Beach Redondo Beach Emma/Eva oil platforms Catalina (Twin Harbor) Santa Monica Pier Venice Pier Venice Beach Dana Point	All species	No restrictions
Newport Pier Redondo Pier Belmont Pier Pier J	Corbina " Surfperches "	One meal every two weeks
Malibu Pier	Queenfish	One meal a month
Short Bank	White croaker	One meal every two weeks
Malibu Point Dume	White croaker "	Do not consume
Point Vicente Palos Verdes - Northwest	White croaker "	Do not consume
White's Point	White croaker	Do not consume
	Sculpin Rockfishes Kelp bass	One meal every two weeks+
Los Angeles/Long Beach Harbors (esp. Cabrillo Pier)	White croaker	Do not consume
	Queenfish Black croaker Surfperches	One meal every two weeks+
Los Angeles/Long Beach Breakwater (ocean side)	White croaker Queenfish Surfperches Black croaker	One meal a month+
Horseshoe Kelp	Sculpin White croaker	One meal a month+

* One meal is about six ounces.

\+ Consumption recommendation is for all the listed species combined.

Species-Specific Recommendations

For the purpose of providing fish consumption guidance based only on a comparison of fish species in the entire study area, the following groups were formed:

SPECIES-SPECIFIC CONSUMPTION RECOMMENDATIONS

FISH SPECIES	CONTAMINATION GROUP	RECOMMENDATION*
White croaker	HIGH	Avoid consumption
Corbina Queenfish Surfperches Sculpin	MODERATE	Consume not more than one meal every two weeks
Black croaker Barred sand bass Rock fishes Kelp bass	LOW	Consumption not restricted
Bonito Mackerel Sand dab Barracuda Opaleye Halfmoon Halibut	LOWEST	Consumption not restricted

* One meal is about six ounces.

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MEMORANDUM

November 9, 1991

TO: Sheila Wiegman, ASEPA

FROM: Bonnie J. Ponwith, DMWR

SUBJ: **METHODS FOR OBTAINING FISHERY DATA**

As we discussed in our phone conversation of 6 November, I am in the process of writing a report on the results of the first year of inshore fishery data collected in the Pago Pago Harbor area. As the report is not yet finalized, I have compiled an abbreviated version containing the methods used and results obtained, which will hopefully answer any questions pertaining to the harvest and catch levels in the inner and outer harbor.

If you need additional information or clarification, please contact me.

THE SHORELINE FISHERY OF GREATER PAGO PAGO HARBOR AND SURROUNDING AREA ON TUTUILA ISLAND, AMERICAN SAMOA

NOVEMBER, 1991

Submitted by:

Bonnie J. Ponwith
Department of Marine and
Wildlife Resources
Pago Pago, American Samoa

SUMMARY

A study was conducted from July 1990 to June 1990 to determine annual effort and catch levels for the inshore reef fishery between the villages of Lauli'ituai and Nu'uuli. Results indicate that an estimated annual effort of 33,746 gear hours resulted in the harvest of 147220 pounds of fish and shellfish in the study area.

CPUE = 4.4#/gear-hr.

INTRODUCTION

Throughout their history, the people of American Samoa have relied on fish and shellfish from the reefs surrounding their islands as a food source. Prior to western influence, the reefs provided a substantial portion of the protein in their diets. The gradual shift from a subsistence base to a cash base economy has reduced the reliance on the reef as a primary food source. With the introduction of refrigeration and canned goods into the territory, reef fishing has become less important for the purpose of meeting protein requirements. At the same time, however, the Territory's human population has increased at a significant rate, putting new pressures on the coastal reef system in the form of the habitat degradation.

A program was established in 1990 to monitor the inshore fishery in a localized region of Tutuila Island, American Samoa. The primary objective of the study was to produce estimates of catch and effort levels for the fishery. Secondarily, analyses on sex and age composition of the fishery participants, how much of the catch was sold or kept and whether people fished in areas other than adjacent to their home village were conducted. The study was conducted in the area between Lauli'ituai and Nu'uuli, a 16-kilometer stretch of shoreline centered around Pago Pago Harbor (Fig. 1). The study area exhibits an extreme range of reef health, from the relatively undisturbed setting in outer villages such as Lauli'ituai, to the heavily impacted, industrialized shores of inner Pago Pago Harbor.

Changes Since Previous Studies

Similar studies were conducted in approximately the same area during 1976 (Hill 1978) and 1977-1978 (Wass 1980). Since the time of those studies, many changes have taken place in the Territory which might have had an impact on the fishery. For example, in 1977-78, there was an *Acanthaster planci* infestation on the reefs surrounding Tutuila Island. Surveys conducted during the outbreak showed the reefs, including the study area, to be heavily infested. A bounty program throughout the island recovered nearly a half a million starfish (Birkeland and Randall, n.d)

Hurricanes hit the island in 1979 and 1990, subjecting the island

Tutuila Island, American Samoa

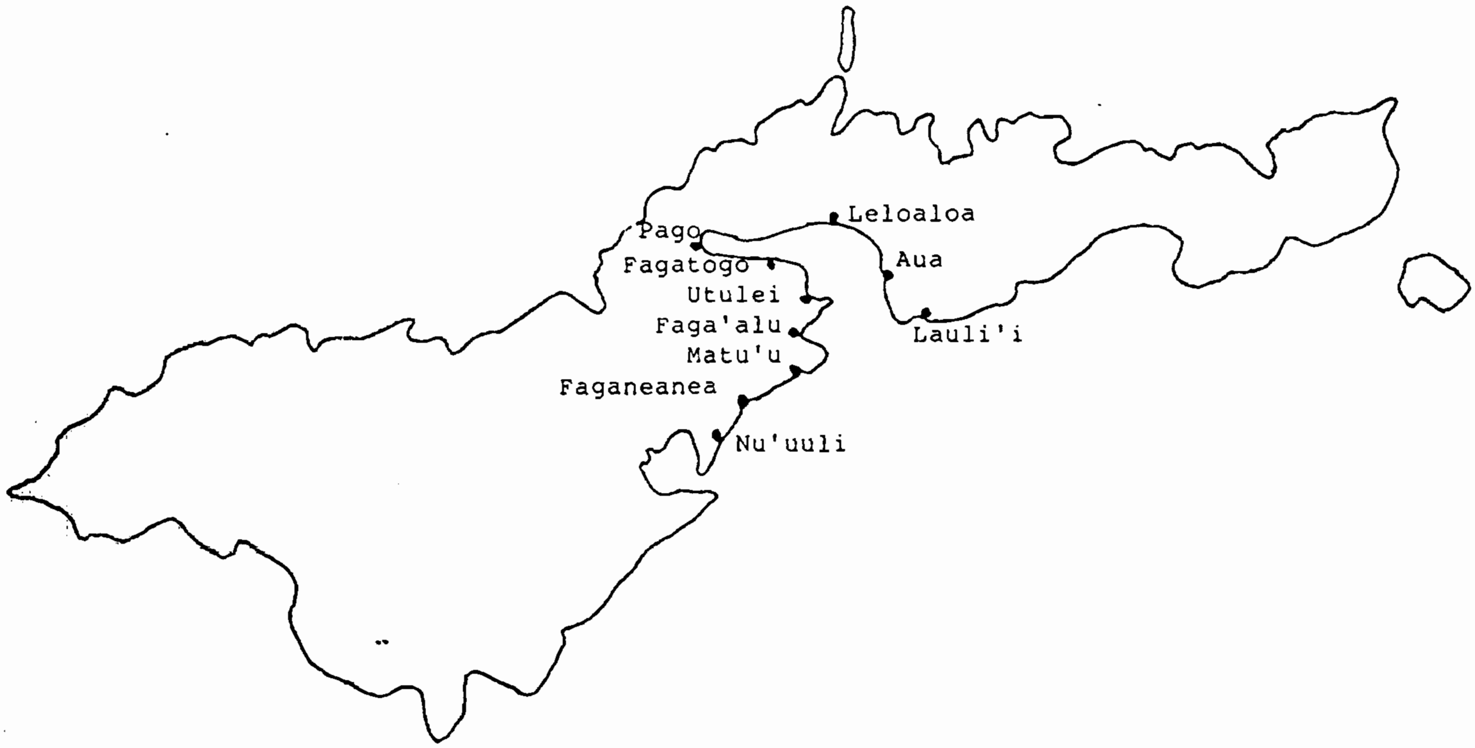

Figure 1. The study area was comprised of the villages in the 16-km stretch between Lauli'i and Nu'uuli on Tutuila Island, American Samoa.

to 75 and 93 knot winds respectively. Although quantitative data on resultant reef damage is sparse, qualitative observations suggest that damage was incurred, particularly in the latter storm.

The reef ecosystem has also been impacted as a result of the significant human population growth that has occurred over the last several years (Fig. 2). Rapid development and the accompanying environmental degradation have affected the study area in many ways. Coastal road improvements were protected with heavily armored banks which encroached on the reef flat. As prime building sites become congested, land clearing for new construction and agriculture on steep slopes has become more common, exacerbating the siltation problems which exist in a high-island environment.

Production levels at the canneries have increased, which has increased the amount of waste the canneries must dispose. A clear trend of increasing total phosphorous and total nitrogen levels in the inner harbor exists over the period 1979 to 1987 (Chamberlin et al 1989). In addition, low dissolved oxygen content due to high nutrient levels are suspected to be the cause of the several fish kills in the inner harbor.

A toxicity study was conducted in the Pago Pago harbor area and the results confirmed the presence of heavy metals, PCBs and pesticides in fish tissue samples taken from the inner harbor (AECOS 1991). Lead concentrations in the fish tissues were high enough (mean concentration 2.9 ppm) to warrant the issuance of a health advisory, recommending that inner harbor fish not be eaten.

METHODS

FIELD SAMPLING

Sampling was conducted three days a week on a revolving schedule to ensure sampling levels within the each time strata were adequate. This structure provided a sample rate, averaged across all time strata, of approximately 6% of all hours in the year.

In a given eight hour sampling shift, two types of data were collected: (1) participation data, which relates to the effort spent to harvest reef resources, and (2)catch data, the results of the harvest efforts.

A series of four, one hour sampling sweeps were made in each sampling shift to collect participation data. A sampling sweep consisted of a drive from Lauli'ituai to Nu'uuli that began on the hour and ended within the same hour, during which all fishing activity was noted on a participation form. The study area is rimmed by a two lane road from which nearly all the reef area can be seen, making it possible to gather participation data from a

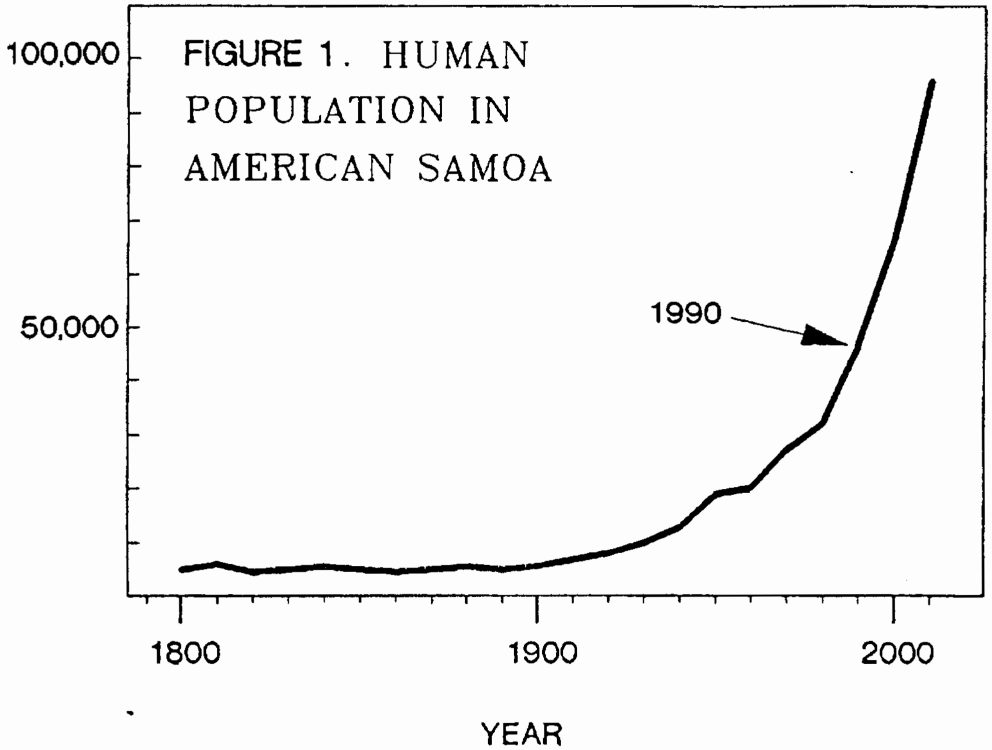

Figure 2. Growth of the human population in American Samoa. (from Craig, P. 1991. How many people can American Samoa support. Guest editorial, Samoa News, Thursday, April 4 1991)

vehicle. Side roads and pull offs were used to view areas which were difficult to see directly from the road.

General information such as date, sampler name, and type of day (week day/week end-holiday) were recorded along with information specific to each observation including time, village, method, number gear units (i.e. number of fishing tools such as rods, spears, etc.) number of people, weather conditions and additional comments. Typically, four sampling sweeps were made each scheduled sampling day.

Catch data were collected opportunistically during the shifts. Most catch sampling was done between sweeps, but if time allowed, catches were sampled during a sweep. Catch data included date, type of day (weekday/weekend-holiday), village, whether the trip was concluded or in progress, time of interview, fishing method used, number of hours fished at the time of the interview, number of gear units (rods, nets, spears, etc.) employed, number of people in the fishing party, whether the catch was to be sold or kept, whether the trip was in the home village of the participant, the age and sex breakdown of the fishing party, and the count and weight of each species or species group caught. Fish were weighed using a spring scale to the nearest ounce. Individuals were only sampled if they had been fishing at least half an hour, and parties that had no catch were recorded as such and included in the computation of CPUE.

ANALYSIS METHODS

Data were punched into a database and a series of interactive, DBase IV programs were used to expand the sample data to annual catch and effort estimates for the study area. All effort estimates are reported in a unit called gear-hours, rather than the more commonly used person-hours, because it is common for a fishing party to include people who are not actively fishing. For example, a fishing party may consist of two people one of whom fishes with a rod and reel while the other holds the catch. The fishing power of that party is actually limited by the amount of gear they have, rather than the number of people participating. Thus, the gear-hour unit produces a more accurate estimate of fishing power.

Expansions of participation data were made by multiplying the mean number of gear units (fishing tools) per hour of observation by day/night, weekday/weekend, method, and habitat by the total number of hours of each strata there were in the year.

A CPUE value for each catch sampled was calculated by dividing the total number of pounds caught by the product of the number of gear units and the number of hours fished. The units for CPUE are, therefore, pounds per gear-hour. Mean CPUE was calculated by summing the CPUE for each interview and dividing the result by the number of interviews. Expanded catches were generated by multiplying the mean CPUE for each stratum by the expanded effort estimate for each respective stratum.

Estimates of species composition were made by multiplying the percent contribution of each species in observed catches to the total estimated catch, by strata.

RESULTS AND DISCUSSION

Effort, Catch and CPUE

Effort estimates are based on 495 sampling sweeps which represented a 6% sampling rate of all hours in the study period. CPUE and catch estimates are based on 366 interviews, which represented 1257 gear hours of effort. Estimated annual effort of 33,746 gear hours resulted in the harvest of 147,22 pounds of fish and shellfish in the study area (Table 1). Fish weights are expressed as whole fish, and shellfish weights include the shell.

Because most of the weaknesses in the study err to the low side, both the effort and catch estimates should be treated as conservative. Visibility is the primary factor responsible for the bias toward underestimation. For example, samplers have difficulty seeing night divers who may be either too deep or too far offshore to detected easily. Heavy rain can also affect the samplers' ability to accurately count people fishing on the reef.

Handline and rod and reel methods were the most commonly used methods and were responsible for the highest landings of the seven methods (Fig. 3) Together, thy accounted for 71% of the total effort and 63% of the total catch. Diving is the only other method that contributed greater than 10% to both catch and effort totals.

Fagatogo and Utulei areas ranked highest in their contributions of 41% and 21% to total catch and 52% and 14% to total effort, respectively (Fig. 4). This was largely due to their accessibility to the atule schools which seasonally congregate in the harbor. Catch and effort levels of all other villages contributed to less than 11% to the totals.

Weekday days and nights (0601 Sunday - 1800 Friday, or 79% of all hours in a week) accounted for 69% of all effort and 82% of all catch. Analysis of catch and effort by method shows that rod and reel, handline and bamboo pole methods were used predominantly during the night, whereas gleaning, diving, throw netting and gill netting methods were used more during daylight hours (Fig. 5). The high use of rod and reel and handline methods during the night is attributable to their popularity as a means of harvesting atule, which are fished mainly at night.

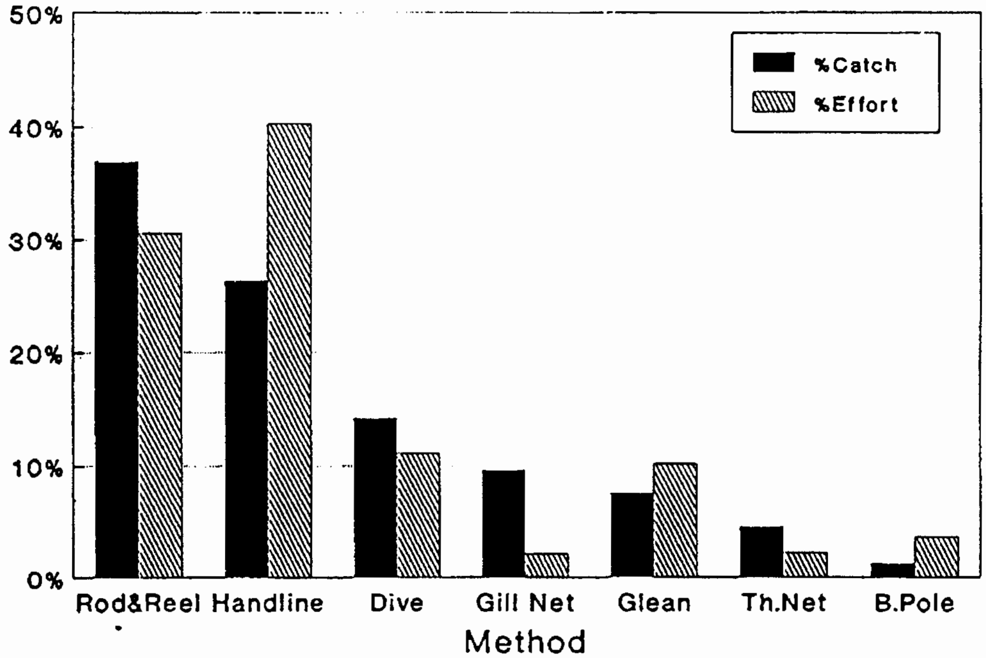

Figure 3. Contribution to total catch (lb) and effort (gear hours) for each fishing method based on a year long study of the inshore fishery between the villages of Lauli'i and Nu'uuli, American Samoa.

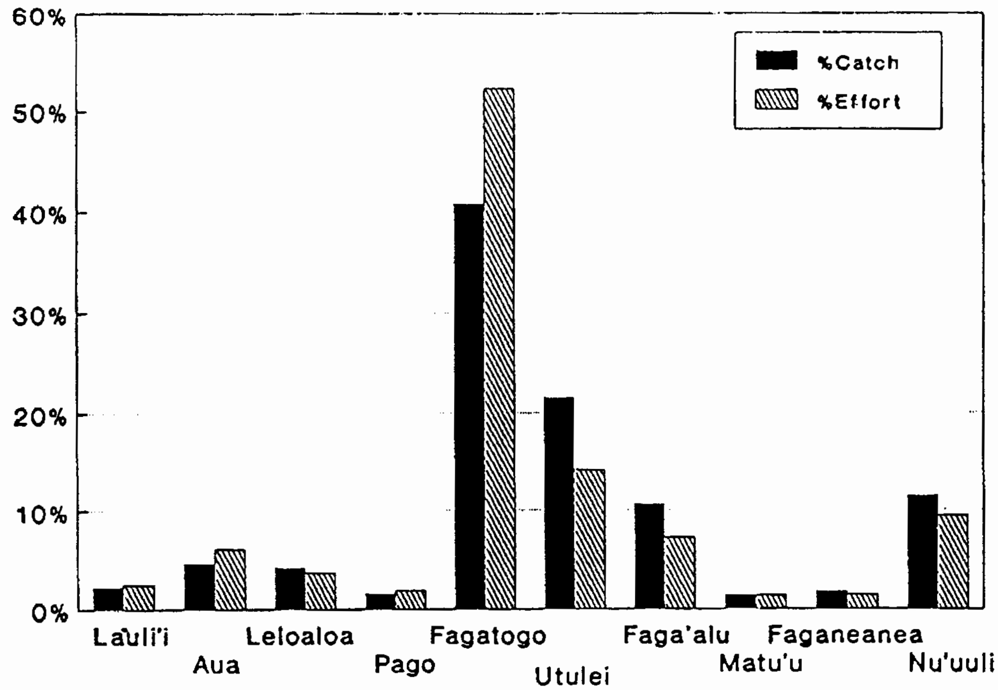

Figure 4. Contribution to total catch (lb) and effort (gear hours) for each area based on a year long study of the inshore fishery between the villages of Lauli'i and Nu'uuli, American Samoa.

CPUE values varied greatly among the various strata from a high of 39.8 lb/gear-hour for Matu'u gill netting to a low of zero lb/gear-hour for Nu'uuli rod and reel fishing and Aua diving. The mean CPUE across all strata was 3.6 lb/gear hour.

Of the seven methods sampled, gill netting had the highest CPUE, 12.2 lb/gear hour, followed by throw netting and diving (Table 2). Handline data included a legitimate, but atypically high catch of 80 lb/gear hour for one catch. If that record were ignored, the handline CPUE would be 1.4 lb/gear hour with a standard deviation of 2.5.

The Matu'u area had the highest area-based CPUE (8.3 lb/gear hour). High throw and gill netting success rates in the catches that were sampled strongly influenced the analysis, due to an overall low sampling rate. Utulei and Faga'alu had the next highest CPUEs, at 4.2 and 2.2 lb/gear hour respectively. High success rates for atule fishing contributed greatly to the high CPUE at Utulei, while high gleaning and diving success rates due to the high octopus harvest can explain the high CPUE at Faga'alu.

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Birkeland, Charles and Richard H. Randall. n.d. Report on the Acanthaster planci (Alamea) Studies on Tutuila, American Samoa. Report to the Director of Marine and Wildlife Resources, Pago Pago, American Samoa. (actually from Appendix B. Results of an Acanthaster planci (crown-of-thorns) survey around Tutuila Island, American Samoa by Richard C. Wass) CR-CT-196

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Table 2. Mean CPUE by grouped sampling strata

		MEAN CPUE	STD	N
BY DAY/NIGHT	DAY	3.74	8.23	212
	NIGHT	2.04	2.62	154
BY METHOD	ROD & REEL	2.86	3.32	113
	HANDLINE	2.11	7.93	110
	BAMBOO POLE	0.71	0.67	17
	GLEANING	1.66	1.86	29
	DIVING	2.92	3.25	38
	THROW NET	4.93	7.35	45
	GILL NET	12.22	16.92	13
BY AREA	LAULI'I	1.83	1.96	5
	AUA	2.78	4.70	25
	LELOALOA	3.44	5.52	11
	PAGO PAGO	3.01	8.87	21
	FAGATOGO	2.44	6.65	167
	UTULEI	4.15	7.94	52
	FAGA'ALU	3.18	3.69	29
	MATU'U	8.25	17.29	6
	FAGANEANEA	3.28	4.12	10
	NU'UULI	3.33	4.36	40

Table 1. Annual catch (lb) and effort (gear hours) by area and method

AREA		ROD & REEL	HAND LINE	BAMBOO POLE	GLEAN	DIVE	THROW NET	GILL NET	TOTAL
LAULI'I	CATCH	540	457	18	726	1232	95	282	3350
	EFFORT	150	71	21	336	221	24	12	835
AUA	CATCH	2186	445	355	498	163	1746	1446	6839
	EFFORT	732	99	305	309	338	122	149	2054
LELOALOA	CATCH	795	428	143	324	1956	1095	1417	6158
	EFFORT	318	90	98	105	381	153	98	1243
PAGO PAGO	CATCH	243	723	122	0	0	1063	115	2266
	EFFORT	140	351	84	0	0	59	4	638
FAGATOGO	CATCH	25251	33492	981	54	0	160	150	60088
	EFFORT	5165	11957	463	16	0	12	48	17661
UTULEI	CATCH	19029	2157	79	834	1488	202	7805	31594
	EFFORT	2776	889	53	148	589	35	283	4773
FAGA'ALU	CATCH	1746	314	68	2670	9645	1069	55	15567
	EFFORT	304	66	102	831	932	159	27	2421
MATU'U	CATCH	271	98	35	597	519	172	349	2041
	EFFORT	69	28	56	143	116	51	4	467
FAGANEANEA	CATCH	1316	62	6	396	296	352	115	2543
	EFFORT	226	8	4	122	74	47	4	485
NU'UULI	CATCH	3115	288	29	4877	5641	468	2356	16774
	EFFORT	448	47	20	1412	1104	67	71	3169
TOTAL	**CATCH**	**54492**	**38464**	**1836**	**10976**	**20940**	**6422**	**14090**	**147220**
	EFFORT	**10328**	**13606**	**1206**	**3422**	**3755**	**729**	**700**	**33746**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street
San Francisco, Ca. 94105-3901

October 31, 1991

MEMORANDUM

SUBJECT: Review of the Draft Design of the Second Phase of the Pago Pago Harbor Toxicity Study

FROM: Norman L. Lovelace, Chief (E-4) NL
Office of Pacific Island and Native American Programs

TO: Janet Hashimoto, Chief (W-7-1)
Oceans and Estuaries Section

We would appreciate your staff's assistance in reviewing the enclosed draft design of the second phase of the toxicity study proposed for Pago Pago Harbor in American Samoa. Dave Stuart and Brian Melzian of your staff provided a very thorough review of the first phase of the study which was very useful and greatly appreciated by the American Samoa Government. Based on the information obtained in the pilot study, it was recommended that a more thorough assessment of the contamination in the harbor be made, which is the purpose of the present proposal. Any recommendations on the design of this second phase would be appreciated.

We have also forwarded a copy of this study design to Arnold Den for his review from a risk assessment perspective.

Should you have any questions, please contact Pat Young at extension 4-1591.

Attachments (2 copies)

Printed on Recycled Paper

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

Serial:448

October 29, 1991

Norman L. Lovelace, Chief
Office of Pacific Island and Native
American Programs
U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, California 94105

Dear Norm:

Enclosed is a draft design of a toxicity study for American Samoa to follow up the pilot toxicity study in Pago Pago Harbor. I request your assistance in review of this study design, any further general recommendations, and recommendations on methods for analysis and detection limits. We would like to begin conducting this study as soon as possible. We are presently determining the cost of the study and starting to initiate funding requests. The American Samoa Government (ASG) has the capability to collect samples, but we will require assistance with analysis and data interpretation.

I appreciate your consideration of our request. You may contact me or Sheila Wiegman for any questions or further information.

Sincerely,

Pati Faiai, Director
American Samoa Environmental
Protection Agency

cc: Peter Craig, DMWR
Lelei Peal, ASCMP
Environmental Coordinator, ASEPA

DRAFT
30 October 1991

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

PROPOSAL TO CONDUCT A TOXICITY STUDY OF PAGO PAGO HARBOR AND SURROUNDING WATERS

PHASE 1. PILOT STUDY OF PAGO PAGO HARBOR (COMPLETED)

Because Pago Pago Harbor has had a long history of industrial and military use, it was selected as the site of a pilot toxicity study in 1990 to see if toxic components were present in the environment. Several fish species, as well as water and sediments, were tested for about 20 different contaminants: heavy metals, pesticides, PCBs, oil/grease, hydrocarbons, and volatile organics.

The pilot study (AECOS 1991) and subsequent EPA review showed that the inner harbor was badly contaminated and the fish caught there were not safe to eat. Consequently, a public health advisory was issued (Appendix 1), a public education effort was initiated, and a proposed study plan for a more detailed follow-up study was formulated (i.e., Phase 2).

PHASE 2. DISTRIBUTION OF CONTAMINATED FISH AND SEDIMENTS IN AMERICAN SAMOA

Proposed Study Design

1. GOALS

Goals of the Phase-2 study are summarized by the need for a health assessment (Is the health of local residents affected by the contamination?) and a field assessment (Where are the fish safe to eat?). The following tasks address these needs:

Health assessment

Task 1. Determine blood level concentrations of lead and other contaminants in selected age groups of people living in the harbor area.

Field assessment

Task 2. Determine background levels of contaminants at unpolluted "control" sites;

Task 3. Verify previous data from inner harbor and, at the same time, provide a reference level of contaminants by which to gauge contamination levels at less polluted sites during the Phase-2 study;

Task 4. Determine at what distance beyond the inner harbor that fish are safe to eat;

Task 5. Examine other coastal areas that may be polluted.

Task 1 is not addressed in this proposal. It is being handled separately by the American Samoa Division of Public Health with assistance from the Center for Disease Control.

2. STUDY PARTICIPATION AND ADMINISTRATION

This study will be conducted using island agency personnel and a contract laboratory for sample analysis. The American Samoa Environmental Protection Agency (ASEPA) will provide overall project oversight. The Department of Marine and Wildlife Resources (DMWR) and American Samoa Coastal Management Program (ASCMP) will participate with ASEPA in decision-making through an interagency committee. DMWR will be responsible for collection of fish and invertebrate samples. Hiring of local fishermen and/or a local coordinator for sample collection many be necessary. Use of DMWR boats will also be needed. Sediment samples will be collected by ASEPA. ASEPA and DMWR will coordinate off-island shipping of samples to the contract laboratory. ASEPA will administer the contract for laboratory services with technical assistance form DMWR.

3. SAMPLE ANALYSIS AND DATA INTERPRETATION

A contractor will be sought, through a bidding process, to complete analysis of samples. The contractor must meet the following requirements:

1. Provide for all test methods and detection limits as contained in the study proposal;

2. Provide ASG with instructions on collection techniques (including grams of tissues required for all tests), storage, and preservation for all tests.

3. Assure the American Samoa Government (ASG) that samples can be safely shipped to insure sample preservation. Samples must be promptly picked up from air terminals.

4. Provide written results of sample results as they are completed. A written summary of all final results with data interpretation is required in a timely manner.

ASG will request continued assistance from the U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration in data interpretation and risk assessment.

4. FIELD SITE SELECTION

To address Tasks 2-5, 14 sampling sites are proposed (Fig. 1); all sites are in shallow waters adjacent to the shoreline:

Task 2. Determine background levels of contaminants at unpolluted "control" sites;

Proposal: 2 control sites, one at each end of Tutuila Island on the north side (Tula and Maloata areas) where human activities are minimal. Prevailing surface water currents in our region are westward but the possibility of nearshore counter-currents is not known. Relatively few people live on the north side of the island.

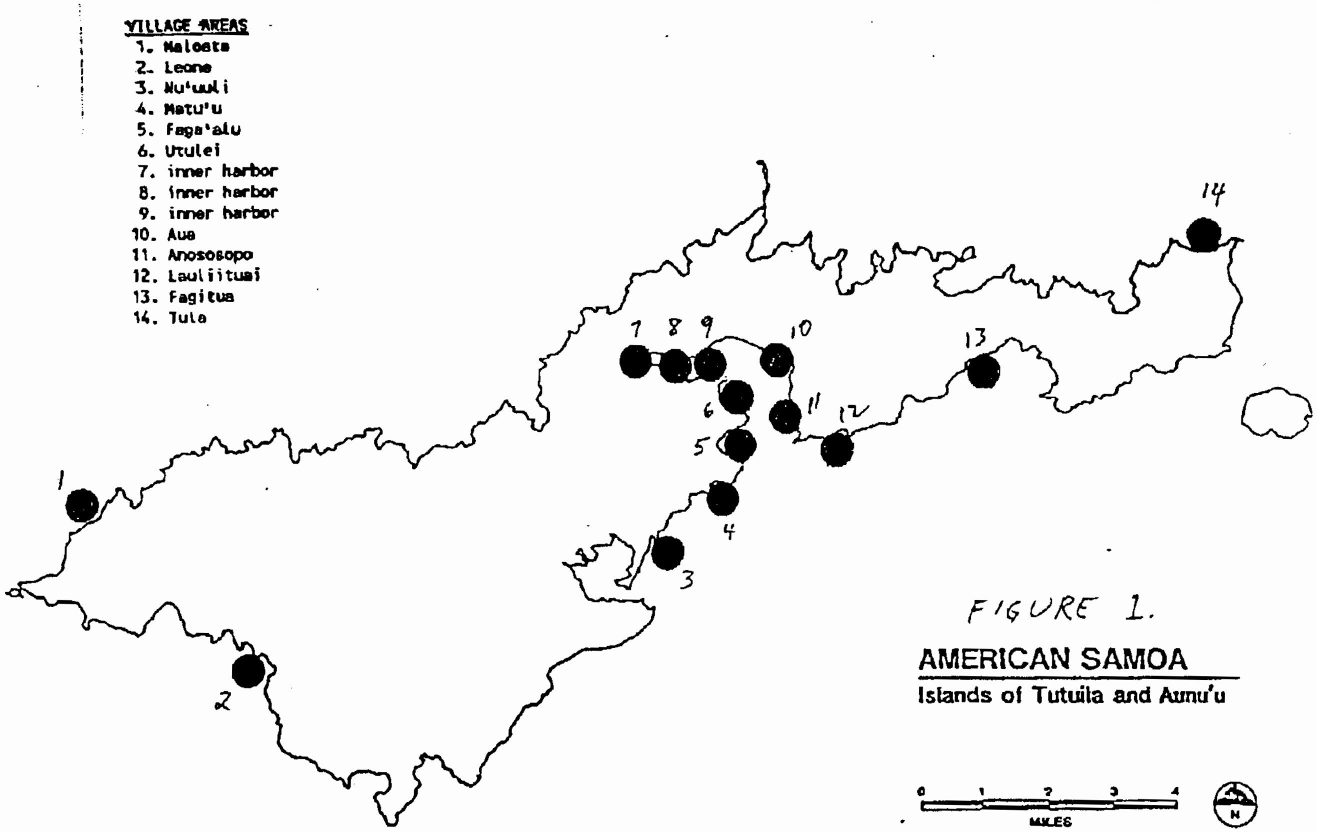


FIGURE 1.

AMERICAN SAMOA
Islands of Tutuila and Aunu'u

Task 3. Verify previous data from inner harbor and, at the same time, provide a reference level of contaminants by which to gauge contamination levels at less polluted sites during the Phase-2 study;

Proposal: 3 sites in inner harbor to insure that a representative assessment of the inner harbor is obtained (sediment samples would be collected at the 3 sites, but fish would be collected anywhere in the inner harbor because the area is small and the fish are mobile).

Task 4. Determine at what distance beyond the inner harbor that fish are safe to eat;

Proposal: 8 sites total, 4 of which are in outer harbor (off the villages of Aua, Anososopo, Utulei, Faga'alu), and 4 are outside the harbor (off the villages of Matu'u, Nu'uuli, Lauliituai, Fagitua). Due to the mobility of the fishes and the relatively small size of the outer harbor, more than 4 sampling sites seems unwarranted. Outside the harbor, we are uncertain whether nearshore currents exist that would carry the contaminated water from the harbor eastward or westward along the coastline past other villages. In addition, we do not know if contaminated harbor fish disperse or migrate outside the harbor.

Task 5. Examine other coastal areas that may be polluted.

Proposal: 1 site of potential pollution at the village of Leone. After the harbor itself, Leone is the next area on the list of potentially contaminated areas (Leone has a relatively high population density). Pala Lagoon is also of concern but is already being tested under another project.

5. SPECIES TO BE ANALYZED

The ideal list of species to be analyzed would include a combination of 3 factors: (a) species consumed by people, (b) species representing all trophic levels, and (c) the same species at all sites. Unfortunately, we cannot select the same species from all sites because fish species occurring in the harbor differ from those found outside the harbor. We have therefore given

... and sample preservation provided by the contract laboratory.

Soil samples will be obtained using the technique and containers provided by the contract laboratory.

priority to species consumed by people in the harbor area where concern over fish toxicity is greatest. For non-harbor sites, we have selected several widely-distributed species. See table of species to be analyzed below.

Note that these are target species -- the actual species collected for analysis will depend on the species available at the time of sampling. The easiest to collect of the species listed below are probably the sea cucumber (detritivore) and turban snail (herbivore). The hardest to collect are probably the jack (carnivore) and mullet (detritivore) because of their low density and high mobility. The atule is an essential species because it comprises about 50% of subsistence catches -- atule will be easy to collect during their runs which occur April-June and August-October.

Fish species	* Inner harbor (n=3 sites)	Outer harbor (n=4 sites)	Non-harbor (n=7 sites)	
HERBIVORE				
pelagi surgeonfish	x*			
alogo surgeonfish		x	x	
turban snail	x*	x		
DETRITIVORE				
mullet spp./sea cucumber	x*	x	x	
MACRO-ZOOPLANKTIVORE				
atule (=bigeye scad)	x*	x**	n.a.	
PISCIVORE				
jacks	x*	x	x	
	---	---	---	
No. samples	5	17	21	= 43
	muscle + liver tissue analysis			x2
	total fish samples			86

* 1 site only for fish from inner harbor because area is small and the fish move around.

** 1 site for atule because they are seasonal and highly migratory

n.a. = probably not available

6. CONTAMINANTS TO BE TESTED

The list of contaminants to be tested was determined through review of the pilot toxicity study and by recommendations from U.S. EPA (Region 9). VOA analysis was excluded because none was identified in the pilot study which focused on the "worst case" situation in inner Pago Pago Harbor. Detection limits and test methods were recommended by U.S. EPA (Region 9).

Analysis	Sediment (n=14)	Fish (n=86)	Soil (n=14)	Test Method	Detection Limit
heavy metals	x	x	x		
pesticides	x	x		EPA 608	0.002-0.24 ppb
PCBs	x	x		EPA 608	
TPH	x	x			
PAH	x	x		EPA 610	0.013-2.3 ppb
TBT	x	x			
Grain size	x				
TOC	x				
Acid volatile sulfides	x				
Total lipids		x			

7. FIELD PROCEDURES

Fish and/or invertebrates, sediments, and soils would be analyzed at all sites.

Fish samples will consist of pooled specimens (whenever possible) collected at each site. Both liver and muscle tissues will be analyzed. Fish will not be dissected in American Samoa because of potential contamination of samples. Instead, whole fish will be frozen in plastic bags as soon as possible. We assume that analysis of samples must be completed within 2 weeks of collection; therefore the contract laboratory must certify date of analysis.

Sediment samples will consist of 3 pooled samples taken at each sample site, utilizing containers and sample preservation provided by the contract laboratory.

Soil samples will be obtained using the technique and containers provided by the contract laboratory.

8. DRAFT BUDGET

Personnel		
Project coordinator, 1 month		(in kind)
Interagency monitoring and review		(in kind)
Sample coordinator, 1 month		1,100
Equipment and Supplies		3,100
Subcontractors		
1. Sample analysis		
a. fish	(86 samples @ 2000)	172,000
b. sediments	(14 samples @ 1500)	21,000
c. soil	(14 samples @ 200)	2,800
2. Sample collection		
a. local fishermen		5,000
Other		
Shipping		5,000
Report preparation		10,000
Sampling boats		(in kind)
	TOTAL	$220,000

9. LITERATURE CITED

AECOS. 1991 A preliminary toxics scan of water, sediment, and fish tissues from inner Pago Pago Harbor in American Samoa. Prepared for American Samoa Government by AECOS, Inc. 970 N. Kalaheo Ave., Kailua, Hawaii. 75p.

Recd 10/29/91

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799
OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

In reply refer to:

Serial:435

October 21, 1991

Norman L. Lovelace, Chief
Office of Pacific Island & Native
American Programs
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Norm:

I would like to provide you with information in the progress of implementation of the findings of the Pago Pago Harbor Toxicity Study. We received the final report from AECOS in September. We met with the Department of Marine and Wildlife Resources (DMWR), the American Samoa Coastal Management Program (ASCMP), and the Division of Public Health (DPH) to formulate a strategy to respond to the study and risk assessment findings. The strategy and progress to date are as follows:

1. A fish consumption health advisory was composed and approved. This has been published in English and Samoan in the local newspapers (attached). It will be published weekly for one month and then monthly.

2. A press release was issued from the Governor's Office on Friday October 11, 1991 and articles were printed in local papers the next week.

3. Two publications will be issued. One is a flyer for the general public, and the other will be a technical bulletin for professionals and interested persons. Signs will be posted, and presentations will be provided to outreach workers and other target groups (fishermen associations, community groups, etc). to assist in spreading the word.

4. The Public Health Division will contact the WHO and CDC to determine the possibility for assistance in blood lead level program.

5. ASEPA and DMWR are drafting a second phase toxicity study plan for review by USEPA and NOAA. This will be utilized to determine the cost of an expanded study and to assist in securing funding.

I appreciate any comments you have on this approach. The assistance of USEPA staff in this study has greatly aided American Samoa. Please pass our appreciation on to those individuals.

Sincerely,

Pati Faiai, Director
American Samoa Environmental
Protection Agency

Attachment:

cc: Pat Young, USEPA, Region IX
Jane Hashimoto, USEPA, Region IX
Brian Melzion, USEPA, ORD., Narragansatt
David Stuart, USEPA, Region IX
Arnold Dun, USEPA, Region IX
Environmental Coordinator, ASEPA

October 11, 1991

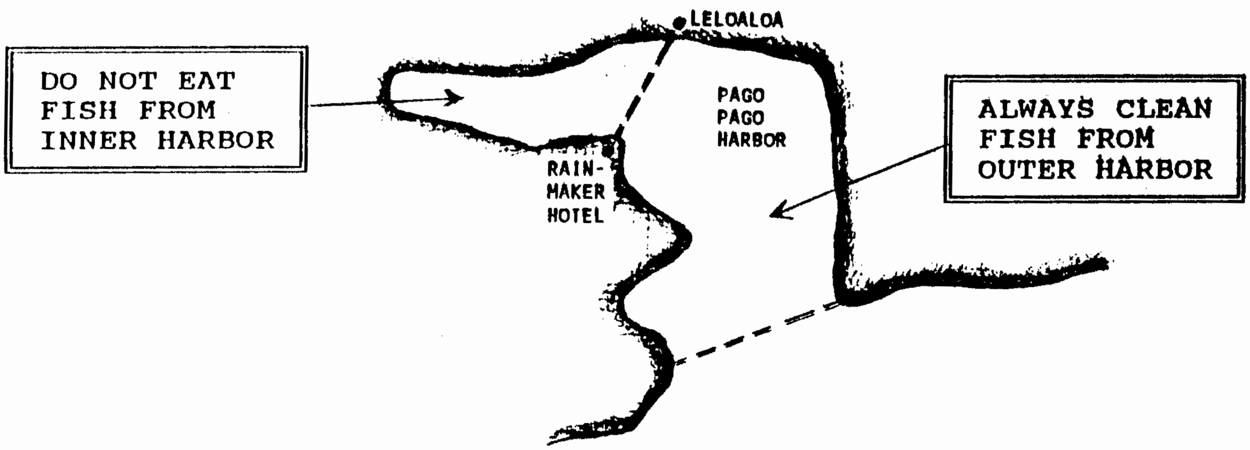
AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to

***** IMPORTANT HEALTH ADVISORY FOR PAGO PAGO HARBOR *****

<u>SUBJECT</u>: CONTAMINATED FISH IN HARBOR

Due to serious contamination problems in Pago Pago Harbor, we advise all people not to eat any fish caught in the inner harbor (see figure below). Fishing may continue in the outer harbor, but fish caught there should be gutted and cleaned before eating -- do not eat whole fish taken anywhere in the harbor. Reduce or eliminate the amount of harbor fish consumed, particularly by children (who are at the greatest health risk).



<u>EXPLANATION</u>: A study has shown that fish caught in the inner harbor are seriously contaminated with lead, other heavy metals, and other contaminants. A health risk analysis conducted by EPA indicates that the concentration of lead alone may reach levels that cause a permanent reduction in the intelligence of children who regularly consume 3-4 meals of harbor fish per week.

While these toxic chemicals are found throughout the fish's body, the fish's liver is particularly poisonous. Therefore, all fish taken anywhere in the harbor should be gutted and cleaned before eating. This includes small fish as well as large fish.

Although sampling for this study was limited to the inner harbor, it seems probable that contamination levels are lower in the outer harbor where there is more water exchange with clean offshore waters. Further studies are needed to verify this.

<u>ISSUING AGENCIES</u>: For more information, contact: American Samoa Environmental Protection Agency (633-2304), Public Health Division (633-4623), Coastal Management Program (633-5155), or Marine and Wildlife Resources (633-4456).

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

Serial:442

October 25, 1991

Arnold Den
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Mr. Den:

I would like to take this opportunity to thank you and David Stuart of your staff for your review of the Pago Pago Harbor Toxicity Study. Your comments and recommendations will be incorporated in the follow up study. At the present time, the policy makers and public have been informed as to the health threats from consumption of fish from Pago Pago Harbor (see attached). Follow up efforts for testing of target populations for blood lead level and toxic compounds in aquatic resources are now underway. Your assistance to date has been greatly appeciated.

Sincerely,

Pati Faiai, Director
American Samoa Environmental
Protection Agency

cc: David Stuart, USEPA, Region IX,
Marine Protection Section
Norman L. Lovelace, USEPA, Region IX, OPINAP

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

Serial:442

October 25, 1991

Kim-Chi Hoang
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Mr. Hoang:

I would like to take this opportunity to thank you and David Stuart of your staff for your review of the Pago Pago Harbor Toxicity Study. Your comments and recommendations will be incorporated in the follow up study. At the present time, the policy makers and public have been informed as to the health threats from consumption of fish from Pago Pago Harbor (see attached). Follow up efforts for testing of target populations for blood lead level and toxic compounds in aquatic resources are now underway. Your assistance to date has been greatly appeciated.

Sincerely,

P. Faiai

Pati Faiai, Director
American Samoa Environmental
Protection Agency

cc: David Stuart, USEPA, Region IX,
Marine Protection Section
Norman L. Lovelace, USEPA, Region IX, OPINAP

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

In reply refer to:

OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

Serial:442

October 25, 1991

Janet Hashimoto, Chief
Marine Protection Section
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Dear Ms. Hashimoto:

I would like to take this opportunity to thank you and David Stuart of your staff for your review of the Pago Pago Harbor Toxicity Study. Your comments and recommendations will be incorporated in the follow up study. At the present time, the policy makers and public have been informed as to the health threats from consumption of fish from Pago Pago Harbor (see attached). Follow up efforts for testing of target populations for blood lead level and toxic compounds in aquatic resources are now underway. Your assistance to date has been greatly appeciated.

Sincerely,

P. Faiai

Pati Faiai, Director
American Samoa Environmental
Protection Agency

cc: David Stuart, USEPA, Region IX,
Marine Protection Section
Norman L. Lovelace, USEPA, Region IX, OPINAP

AMERICAN SAMOA

news release ★ ★ ★ ★

OFFICE OF THE GOVERNOR, PAGO PAGO, AMERICAN SAMOA 96799
CONTACT: The Press Office - (684) 633-4116

October 11, 1991

"ASG ISSUES FISH CONSUMPTION ADVISORY"

The American Samoa Government (ASG) has issued a fish consumption advisory for the Pago Pago Harbor. The advisory follows a review of the results of a pilot study on the amount of toxic chemicals present in the seawater, sediment and fish in the inner Pago Pago Harbor. The health advisory warns that:

Due to serious contamination problems in Pago Pago Harbor, we advise all people not to eat any fish caught in the inner harbor until further notice. Fishing may continue in the outer harbor, but fish caught there should be gutted and cleaned before eating -- do not eat whole fish taken anywhere in the harbor. Reduce or eliminate the amount of harbor fish consumed, particularly by children (who are at the greatest health risk).

The Department of Marine and Wildlife Resources (DMWR) and American Samoa Environmental Protection Agency (ASEPA), and the American Samoa Coastal Management Program (ASCMP) completed the study. Findings of the pilot study are that fish tested reveal levels of the arsenic, chromium, and lead that are of concern. Risk assessment calculations by the U.S. Environmental Protection Agency (USEPA) show that the high levels of metals in fish tissue from the inner harbor may cause adverse health effects. For example, the levels of lead concentration are of concern for children as health effects occur even at very low levels. Modeling completed by the USEPA revealed that 70%-80% of the children could have a blood level concentration such that intelligence quotient (IQ) can be permanently and adversely affected. Based on USEPA recommendations, a testing program for blood lead level is being designed.

Sources of toxic pollutants found in this study are most likely due to the accumulation of contaminants from industrial, natural, and military uses over the past century. Existing discharges to Pago Pago Harbor are not necessarily contributing to the problem. Cannery discharges are primarily nutrients and show no toxic nor high metal concentrations. Further testing on other sources may be necessary. ASG will pursue further toxicity testing of Pago Pago Harbor to broaden the information available. Until the time these studies are complete, it is recommended that the health advisory be followed. Fish from other locations around Tutuila Island are considered safe for consumption.

***

For further information on this Press Release, call Sheila Wiegman of American Samoa Environmental Protection Agency at 633-2304.

October 11, 1991

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799

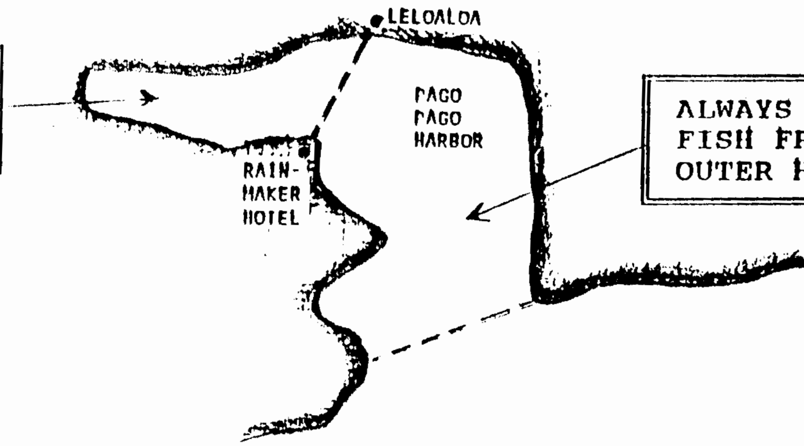
In reply refer to

***** IMPORTANT HEALTH ADVISORY FOR PAGO PAGO HARBOR *****

SUBJECT: CONTAMINATED FISH IN HARBOR

Due to serious contamination problems in Pago Pago Harbor, we advise all people not to eat any fish caught in the inner harbor (see figure below). Fishing may continue in the outer harbor, but fish caught there should be gutted and cleaned before eating -- do not eat whole fish taken anywhere in the harbor. Reduce or eliminate the amount of harbor fish consumed, particularly by children (who are at the greatest health risk).

DO NOT EAT FISH FROM INNER HARBOR



ALWAYS CLEAN FISH FROM OUTER HARBOR

EXPLANATION: A study has shown that fish caught in the inner harbor are seriously contaminated with lead, other heavy metals, and other contaminants. A health risk analysis conducted by EPA indicates that the concentration of lead alone may reach levels that cause a permanent reduction in the intelligence of children who regularly consume 3-4 meals of harbor fish per week.

While these toxic chemicals are found throughout the fish's body, the fish's liver is particularly poisonous. Therefore, all fish taken anywhere in the harbor should be gutted and cleaned before eating. This includes small fish as well as large fish.

Although sampling for this study was limited to the inner harbor, it seems probable that contamination levels are lower in the outer harbor where there is more water exchange with clean offshore waters. Further studies are needed to verify this.

ISSUING AGENCIES: For more information, contact: American Samoa Environmental Protection Agency (633-2304), Public Health Division (633-4623), Coastal Management Program (633-5155), or Marine and Wildlife Resources (633-4456).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

01 OCT 1991

MEMORANDUM

SUBJECT: Review of Pago Pago Harbor Toxicity Study

FROM: David Stuart W-7-1 D Stuart

THRU Janet Hashimoto, Chief (W-7-1) Janet Y. Hashimoto
Marine Protection Section

TO: Norm Lovelace, Chief (E-4)
Office of Pacific Islands and Native American Programs

The following comments are part of our section's response to your June 7, 1991 memo regarding the Pago Pago Harbor Toxicity Study. Dr. Brian Melzian also reviewed this toxicity study independently. His comments are attached.

We believe the AECOS Report is basically flawed in assuming the validity of reference data in Hawaiian harbor sites for interpreting the significance of the Pago Pago Harbor results. The geomorphology, hydrology and anthropogenic history of the two areas are not necessarily similar. Even if they were, the Hawaiian harbor sites do not represent the natural ambient conditions required for reference sites. A more valid approach for comparison with the Inner Pago Pago Harbor data would be to collect simultaneous data from water, sediment and fish tissue samples at sites in the more pristine outer Pago Pago Harbor area (e.g., between Breakers Point and Tutululu Point).

We do agree with AECOS that it is appropriate to use Hawaii's Acute and Chronic Saltwater Quality Standards (adopted in January 1990) for recommended heavy metal and organic compound limiting values in tropical marine waters, such as in Pago Pago Harbor. With few omissions, Hawaii's toxic pollutant standards are based on EPA's 1987 revised "Quality Criteria for Water" (WQC) (EPA 440/5-86-001). These WQC present scientific data and guidance which are updated to reflect the latest Agency recommendations on acceptable limits for aquatic life and human health "four-day average concentration limits or 24-hour average limits, whichever is most current, as standards" (ASEPA, 1990, p. 12). Thus, for those few compounds where Hawaii has not established numeric limits, EPA criteria should also provide appropriate guidance.

The real problem for this AECOS survey, however, is not so much the use of acceptable saltwater standards/criteria, but the ability to analyze the mediums adequately to detect levels of the given priority pollutants contained. The following comments respond to specific sections of the report:

Heavy Metals in Sea Water

We do not agree that Pago Pago Harbor "sea water concentrations of most of the metals were below detection limits" (AECOS, pp. 11, 30). Using U.S. EPA-approved furnace, distillation, and cold vapor methods (U.S. EPA, 1984. Guidelines establishing test procedures for the analysis of pollutants. Fed. Reg. 49:43234-43436), much lower detection limits for heavy metals can be achieved (i.e., in ppm: Ag-0.001, Cd-0.001, Cr-0.005, Pb-0.01, Hg-0.0002, Ni-0.01, Zn-0.001). As the result of using detection limits above the recommended standards/criteria, there is no real way of knowing whether or not the mean values of Ag, Cd, Hg, Ni in the sea water of Pago Pago Harbor exceed standards/criteria. We do know that Cu and Zn concentrations exceeded recommended limiting values only because detection levels were obtained at or below the standards/criteria values for marine waters.

Heavy Metals in Sediments

We agree that heavy metal concentrations measured in Pago Pago Harbor sediments when compared to the "informal" EPA sediment classification (EPA, 1977) suggest that harbor sediments are moderately to heavily polluted with As, Cr, Cu, Ni, and Zn. However, for reasons given above, comparing these sediment values with similar high levels of these metals in Hawaiian marine and estuarine environments is questionable.

Heavy Metals in Fish Tissue

When compared to U.S. EPA "Water and Fish Ingestion Limits", the results of the AECOS Pago Pago Harbor fish tissue (liver and muscle) survey indicate potentially high body burdens of Cd, Cr, Ni, Hg, Pb, and Zn; but when burdens in muscle tissue only are measured, just Cr and Pb (no Ag criteria developed yet) indicate significantly high risk. Nickel body burdens in both liver and muscle also exceed U.S. EPA criteria for "Fish Consumption". Since all of the fish studied "are commonly found in the Harbor, and regularly caught and consumed by local residents" (AECOS, p. 4), these data are possibly the most significant findings of the survey.

Organic Priority Pollutants in Sea Water, Sediment, Fish Tissue

AECOS tested for 19 different chlorinated pesticides, seven different PCBs, and 16 different PAHs in seawater, sediment and fish tissues; and 34 volatile organics in sea water and sediment (pp. 31-33 and Appendices B through E, results of pesticides in seawater analyses were not included). AECOS laboratory analyses employed Method 211.100 (FDA-PAM, Vol. I) and U.S. EPA Method 8080. Unfortunately, these methods do not allow low enough detection limits to pick up small amounts of the pesticides, PCBs, PAHs and volatile organics. For instance, EPA's "Fish Consumption and Human Health WQC" recommendations are in the range of 0.000024 - 159 ppb for pesticides, 0.000079 ppb for PCBs, and 0.031 - 54 ppb for PAHs (established volatile organics limits range considerably higher).

U.S. EPA Method 8080 has now been replaced by EPA Test Method: Organochlorine Pesticides and PCBs - Method 608 (copy enclosed). Much lower detection limits can be reached with Method 608 for both pesticides and PCBs. For pesticides, the range is 0.002 - 0.24 ppb, as compared to the AECOS results of 5.0 - 500 ppb. Similar lower detection levels for the seven PCBs could probably be obtained using Method 608. PCB-1242, for instance, can be detected at levels around 0.065 ppb, as compared to the AECOS obtained detection limits of 1,000 - 3,000 ppb.

AECOS does not describe methods for analyzing for PAHs and volatile organics. But whatever methods were used, it appears that detection limits obtained for these compounds is also too high: PAHs in sediments ranged from 3,500 to 7,000 ppb, in fish muscle from 50 to 5,000 ppb, and in fish liver from 1,000 to 20,000 ppb; while volatile organics in sea water and sediment ranged from 7.5 to 50 ppb.

For PAHs, EPA recommends using high pressure liquid chromatography described in EPA Test Method: Polyaromatic Hydrocarbon - Method 610 (copy enclosed), which will allow detection levels for PAHs in the range of 0.013 - 2.3 ppb. For volatile organic compounds, EPA recommends using the analytic techniques found in EPA Test Method: Volatile Organics - Method 601 (copy enclosed), which will allow detection levels in the range of 0.02 - 1.18 ppb.

Oil and Grease / Total Petroleum Hydrocarbons

Tables of the actual sample results for oil and grease and total petroleum hydrocarbons should be included in the report. There should also be a discussion of the reasons for the rather high sediment oil and grease values (300 - 7,000 ppm). Even though there are no standards/criteria available, these are sizable concentrations found in sediments.

Sediment Grain Size

There are good graphic representations of the sediment grain size distributions at various sites, but no discussion of the results.

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799
OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

In reply refer to:

Serial: 451

September 20, 1990

Norman L. Lovelace
Chief
Office of Pacific Island and Native
American Programs
U.S. Environmental Protection agency
75 Hawthorne St
San Francisco, CA 94105

Dear Mr. Lovelace:

Attached are the revised American Samoa Water Quality Standards (ASWQS) and supporting documentation for your review and approval. Each of the requirements listed in 40 CFR 131.6 are provided for in the attachment except the certification by the Territorial Attorney General that the ASWQS were duly adopted pursuant to Territorial law. This will be submitted upon receipt.

The American Samoa Environmental Quality Commission considered the ASWQS at a meeting held on September 7, 1990. All comments and information submitted verbally and in writing at the April 11, 1990 public hearing and during the comment period were considered. No changes to the proposed standards were recommended and the ASWQS were adopted at that meeting. Please feel free to contact me if you have qhestions or require further information.

Sincerely,

Pati Faiai, Executive Secretary
Environmental Quality Commission

cc: Env. Coordinator, ASEPA

WATER QUALITY STANDARDS (1989 Revision)

Sections:

24.0201	Definitions
24.0202	Policy of Water Quality Antidegradation
24.0203	Authority
24.0204	Standards Review
24.0205	Wastewater, Septic Tanks and Cesspools
24.0206	Water Classifications-Uses Protected, Prohibited
24.0207	Standards of Water Quality
24.0208	Zones of Mixing
24.0209	Permit Required
24.0210	Water Quality Certification
24.0211	Enforcement, Compliance, and Water Quality Monitoring

24.0201 Definitions

As used in this chapter and in conformance with the Federal Water Pollution Control Act PL-92-500 as amended:

(a) "ambient condition" means the water quality condition that occurs in the waters of interest when these waters are not influenced by the proposed new activity or discharge;

(b) "American Samoa Environmental Protection Agency (ASEPA)" means the agency responsible for carrying out the mandates of the EQC;

(c) "discharge of a pollutant" means any addition of any pollutant to the waters of American Samoa from any point source;

(d) "embayment" means a body of water subject to tidal action and bounded by headlands which restrict the exchange of water with the open ocean. A bay or lagoon is an embayment if the ratio of the volume of water in the bay in (cubic feet) to the cross-sectional area (square feet) of the bay at the entrance is more than 700, when determined at mean lower low water. The residence time of water in embayments, as compared to open coastal areas, allows for the accumulation of land drainage materials which influence water quality and marine ecosystems.

(e) "Environmental Quality Commission (EQC)" means the Environmental Quality Commission of the American Samoa Government (ASG);

(f) "fresh surface waters" means all fresh territorial waters including perennial, intermittent, and ephemeral freshwater streams, all natural and artificial impoundments, springs, seeps and wetlands, including coastal wetlands not surface-connected to the ocean. This includes all surface territorial waters that are not embayments, open coastal waters, or ocean waters;

(g) "geometric mean" is defined as n th root of the products of C to C in which n is the number of days samples were analyzed during the period and C is the concentration of the parameter found on each day of sampling.

(h) "ground water" means water in the part of the ground that includes all subsurface waters, basal and parabasal water, perched water, water percalating through the unsaturated zone, and all saline waters below and along the perimeter of the basal fresh water body;

(i) "light penetration depth" means the depth reached by one percent of the sunlight incident on the surface of a body of water as measured by a horizontal plate photometer;

(j) "natural" means free of substances or conditions, which are attributable to the activities of man;

(k) "nonpoint source pollution" is defined as pollution caused by sediments, nutrients and organic and toxic substances originating from land use activities and/or from the atmosphere, which are carried to receiving waters by runoff at a rate that exceeds natural levels.

(l) "ocean waters" means those waters that extend from the 100-fathom (600-foot or 183-meter) depth contour seaward;

(m) "open coastal waters" means those waters that begin at the shoreline and extend seaward to the 100-fathom (600-foot or 183-meter) depth contour from mean lower low water. This category includes small bays with good water movement which do not qualify as embayments.

(n) "Pago Pago Harbor" is defined as landward of a line drawn from Niuloa Point to Breaker's Point;

(o) "Pala Lagoon" is defined that body of water inside a line drawn from the eastern most point of the airport to the nearest part of Coconut Point;

(p) "person" means any individual, partnership, firm, state, federal government, association, municipality, public or private corporation, subdivision or agency of the territory, trust, estate or any other legal entity or interstate body;

(q) "point source" means any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged;

(r) "pollutant" means dredged spoil, sediment, solid waste, petroleum product, incinerator residue, sewage, garbage, sewage sludge, munition, chemical waste, biological material, radioactive material, heat, wrecked or discarded equipment, rock, sand, excavated material, or industrial, municipal, and agricultural waste discharged into water;

(s) "pollution" means the manmade or man induced alteration of the physical, chemical, biological, or radiological condition of territorial waters;

(t) "process waste water" means any water which comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by product, or waste product during manufacturing or processing operations;

(u) "receiving water" means any water body receiving a pollutant;

(v) "territorial waters" means waters of the United States as defined in 40 CFR 122.2, that are located within the jurisdiction of the territory;

(w) "zone of mixing" means any water body receiving water around a point source within which specific modifications of applicable water quality standards are permitted by the EQC.

24.0202 Policy of Water Quality Degradation

(a) It shall be the policy of the Environmental Quality Commission (EQC) that existing water uses and level of water quality necessary to protect existing uses shall be maintained and protected. No further water quality degradation which would interfere with or become injurious to these existing uses is allowable. Existing uses are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standard.

(b) Waters whose existing quality exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water shall be maintained and protected unless and until the EQC finds, after full satisfaction of the intergovernmental coordinating and public provisions contained in the Environmental Quality Act (Title 24, ASCA) that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In no event, however, may degradation of water quality interfere with or become injurious to existing uses. Implementation of the antidegradation policy shall be in accordance with all existing rules and regulations including those on septic tanks, special management areas, and American Samoa Coastal Management Program policies.

(c) No further degradation shall be allowed in high quality waters which constitute an outstanding public resource or in waters of exceptional recreational or ecological significance. Waters which receive this protection shall be classified as unique waters by the EQC.

(d) No further degradation shall be allowed in any water body which would destroy the critical habitat for a threatened or endangered species which is historically or presently known to be associated with such waters. These water bodies will be classified as unique by the EQC.

(e) The EQC may permit or approve limited degradation only in accordance with "Guidance on Implementing the Antidegradation Revisions of 40 CFR 131.12, U.S. Environmental Protection Agency, Region 9, June 3, 1987. Prior to granting limited degradation privileges, the EQC shall determine that the proposed level of water quality is adequate to protect existing uses and that there has been achieved and shall continue to be achieved:

(1) the highest statutory and regulatory requirements for all new or existing point sources;

(2) feasible management of regulatory programs in accordance with Section 208 of the Clean Water Act; and

(3) all cost-effective and reasonable best management practices for nonpoint source control.

(f) In those cases where potential water quality impairment associated with a thermal discharge is involved, nothing in these regulations or their implementation shall be inconsistent with Section 316 of the Clean Water Act.

24.0203 Authority

These standards of water quality and the classification of the waters of the Territory of American Samoa, according to their present and future beneficial uses, have been prepared as required by the Federal Water Pollution Control Act of 1972, as amended, and in accordance with the territorial Environmental Quality Act, 24.0101 through 24.0169 ASCA.

24.0204 Standards Review

The EQC may review the standards codified in this chapter or develop additional water quality standards which may be based upon measurements of selected physical, biological, and chemical indicators for the waters of the territory. The EQC will review existing standards at least once every three years.

24.0205 Wastewater Discharges, Septic Tanks

(a) Any public or private development which would constitute a source of pollution to territorial waters is required to provide the degree of waste treatment and/or operational practices necessary to preserve the quality of these waters.

(b) Septic tank siting, construction, and operation shall be governed by public health rules, water quality standards, building codes, and sewer system use regulations.

24.0206 Water Classifications-Uses Protected, Prohibited.

(a) Fresh Surface Waters

(1) All fresh surface waters are to remain in as nearly their natural state as possible. Fresh surface waters are designated for public or domestic water supply and shall be protected and preserved so they meet National Primary Drinking Water Regulations (NPDWR) and those in the Public Health Drinking Water Standards which are not superseded by NPDWR.

(2) There shall be no discharges of treated or untreated sewage, industrial wastes, or other material attributable to the activities of man into fresh surface waters.

(3) Protected uses for fresh surface water.
(A) Potable water supply;
(B) The support and propagation of aquatic life and wildlife;
(C) Aesthetic enjoyment; and
(D) Compatible recreation in and on the water; e.g. fishing.

(4) Prohibited uses include but are not limited to:
(A) Bathing, as well as washing clothes and dishes;
(B) Point-source discharges;
(C) Animal pens over or adjacent to any impoundment or stream (25.1604 ASCA);
(D) Dead animal disposal (25.1606 ASCA);
(E) Dredging and filling activities;
(F) Hazardous and radioactive waste discharges; and
(G) Dumping of solid waste.

(5) Zones of mixing will not be permitted in fresh surface waters.

(b) Ground Waters

(1) All ground waters are to remain in as nearly their natural state as possible. Ground waters are designated for public or domestic water supply and shall be protected and preserved so they meet NPDWR and those Public Health Drinking Water Standards which are not superseded by NPDWR.

(2) There shall be no discharges of treated or untreated sewage, industrial wastes, or other material attributable to the activities of man into territorial ground waters which have a naturally occuring salinity of less than 10,000 mg/l. This shall include any activities in which discharges occur on land or above the ground water table which could potentially contaminate underlying ground waters, except septic tanks sited and constructed as approved by the Division of Public Health and the Wastewater Division of the American Samoa Power Authority.

(3) Protected uses for ground waters
    (A) Potable water supply

(4) Prohibited uses include but are not limited to:
    (A) Point-source discharges into ground waters of less than 10,000 mg/l salinity;
    (B) Discharges from animals pens;
    (C) Hazardous and radioactive discharges, and
    (D) Nonpoint source pollution.

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(c) Embayments

(1) All embayments are to remain in as nearly their natural state as possible.

(2) Pago Pago Harbor: Pago Pago Harbor has been designated by the American Samoa Government to be developed into a transhipment center for the South Pacific. Recognizing its unique position as an embayment where water quality has been degraded from the natural condition, the EQC has established a separate set of standards for Pago Pago Harbor.

(A) Protected uses for Pago Pago Harbor

(I) Recreational and subsistence fishing;
(II) Boat-launching ramps and designated mooring areas;
(III) Subsistence food gathering; e.g. shellfish harvesting;
(IV) Aesthetic enjoyment;
(V) Whole and limited body-contact recreation, e.g. swimming, snorkeling, and scuba diving;
(VI) Support and propagation of marine life;
(VII) Industrial water supply;
(VIII) Mari-culture development;
(IX) Normal harbor activities; e.g. ship movements, docking, loading and unloading, marine railways and floating drydocks; and
(X) Scientific investigations.

(B) Prohibited uses include but are not limited to:

(I) Dumping or discharge of solid waste;
(II) Animal pens over or adjacent to any shoreline (25.1604 ASCA);
(III) Dredging and filling activities; except as approved by the EQC in accordance with the Environmental Quality Act (Title 24, ASCA);
(IV) Hazardous and radioacive waste discharges; and
(V) Dishcarge of oil sludge, oil refuse, fuel oil, or bilge water, or any other waste water from any vessel or unpermitted shoreside facility (20.1714 ASCA).

(C) Zones of mixing will be allowed in Pago Pago Harbor by EQC permit only. No zones of mixing will be allowed within 500 feet of Goat Island Point or beneath this surface area to the bottom of the harbor.

(3) Special embayments

(A) Fagatele Bay is designated as marine sanctuary by the Department of Commerce because of pristine water quality, remote location; and rich underwater resources. Therefore, the EQC has assigned specific water quality standards to prohibit any reduction in water quality in the bay.

(B) Pala Lagoon: Pala Lagoon is a shallow embayment that is important as a breeding ground for the marine life of the territory. It has been designated by the American Samoa Coastal Management Plan as a special area. Therefore, the EQC has also classified the Pala Lagoon as a special embayment.

(C) Protected uses:

(I) Recreational and subsistence fishing;
(II) Subsistence food gathering, e.g. shellfish harvesting;
(III) Aesthetic enjoment;
(IV) Whole and limited body-contact recreation, e.g. swimming, snorkeling, surfing, and scuba diving;
(V) Support and propagation of marine life;
(VI) Mari-culture development, and
(VII) Scientific investigations.

(D) Prohibited uses include but are not limited to:

(I) Dumping or discharge of solid or industrial waste material;
(II) Animal pens over or adjacent to any shoreline (25.1604 ASCA).
(III) Dredging and filling activities, except when permitted by the EQC.
(VI) Hazardous and radioactive waste discharges; and
(V) Discharge of oil sludge, oil refuse, fuel oil, or bilge water, or any other waste water from any vessel or unpermitted shoreside facility (20.1714 ASCA).

(E) Zones of mixing will not be allowed in Pala Lagoon or Fagatele Bay.

(4) Other Embayments: All embayments of the territory excluding Pago Pago Pago Harbor, Pala Lagoon, and Fagatele Bay are included in this category.

(A) Protected uses:

(I) Recreational and subsistence fishing;
(II) Boat-launching ramps and designated mooring area;
(III) Subsistence food gathering; e.g. shellfish harvesting;
(VI) Aesthetic enjoyment;
(V) Whole and limited body-contact recreation, e.g., bathing, swimming, snorkeling, surfing, and scuba diving;
(VI) Support and propagation of marine life; and
(VII) Mari-culture development

(B) Prohibited uses include but are not limited to:

(1) Dumping or discharge of solid or industrial waste material;
(II) Animal pens over or adjacent to any shoreline (24.1604 ASCA)
(III) Dredging and filling activities, except when permitted to provide compliance with water quality standards;
(VI) Hazardous and radioactive waste discharges; and
(V) Discharge of oil sludge, oil refuse, fuel oil, or bilge water from any vessel or shoreside facility (20.1714 ASCA)

(C) Zones of mixing will be allowed in the embayments included in this paragraph by EQC permit only.

(d) Open Coastal Waters.

(1) Protected uses:

(A) Commercial, subsistence, and recreational fishing;

(B) Scientific investigations;

(C) Whole and limited body-contact recreation, e.g., swimming, snorkeling, surfing, and scuba diving;

(D) Harbors and boat-launching ramps;

(E) Commercial and recreational boating;

(F) The support and propagation of marine life; and

(G) Aesthetic enjoyment

(2) Prohibited uses include but are not limited to:

(A) Offshore oil recovery

(B) Dumping or discharge of solid or industrial waste material;

(C) Discharge of oil sludge, oil refuse, fuel oil, or bilgewaters, or any other waste water from any vessel or unpermitted shoreside facility (20.1714 ASCA);

(D) Animal pens over any bay, ocean, or other body of freshwater or saltwater (24.1604 ASCA);

(E) Dredging and filling activities except when permitted by the EQC in accordance with Environmental Quality Act Title 24; and

(F) Hazardous and radioactive waste discharges.

(G) No point source discharges will be permitted in Manu'a off Ofu Park and between Ofu Park and the Ofu-Olosega Bridge within 1,000 feet of the bridge.

(e) Ocean Waters.

(1) Protected uses:

(A) Commercial, subsistence, and recreational fishing;

(B) Scientific investigations;

(C) Commercial and recreational boating;

(D) The support and propagation of marine life;

(E) Aesthetic enjoyment; and

(F) Whole or limited body-contact recreation.

(2) Prohibited uses include but are not limited to:

(A) Discharge of oil sludge, oil refuse, fuel oil, or bilge waters, or any other waste water from any vessel (20.1714 ASCA);

(B) Dumping of solid or industrial waste materials without an EPA ocean dumping permit, except where permitted by exclusions in the federal ocean dumping regulations; and

(C) Hazardous and radioactive waste discharges.

24.0207 Standards of Water Quality

(a) Waters Generally. The following standards apply to all territorial and ground waters including but not limited to fresh surface waters, ground waters, embayments, open coastal waters, and oceanic waters of the territory, except as otherwise provided in Section 24.0208 (Zones of Mixing).

(1) They shall be substantially free from materials attributable to sewage, industrial wastes, or other activities of man that will produce objectionable color, odor, or taste, either of itself or in combinations, or in the biota.

(2) They shall be substantially free from visible floating materials, grease, oil, scum, foam, and other floating material attributable to sewage, industrial wastes, or other activities of man.

(3) They shall be substantially free from materials attributable to sewage, industrial wastes, or other activities of man that will produce visible turbidity or settle to form objectionable deposits.

(4) They shall be substantially free from substances and conditions or combinations thereof attributable to sewage, industrial wastes, or other activities of man which may be toxic to humans, other animals, plants, and aquatic life or produce undesirable aquatic life.

(5) The fecal coliform concentration shall not exceed a geometric mean of 100 per 100 ml in not less than four samples approximately equally spaced over a thirty-day period, nor shall any sample exceed 200 per 100 ml in more than ten percent of the samples.

(6) The temperature shall not deviate more than 1.5 degrees Fahrenheit from conditions which would occur naturally and shall not hourly fluctuate more than 1 degree Fahrenheit nor exceed 85 degree Fahrenheit due to the influence of other than natural causes.

(7) Radioactivity:

(A) Since human exposure to any ionizing radiation is undesirable, the concentration of radioactivity in natural waters will be maintained at the lowest practicable level.

(B) No radioactive materials shall be present in natural waters as a consequence of the failure of an installation to exercise appropriate controls to eliminate releases.

(C) The concentration of radioactivity shall not:

(I) result in accumulations or radioactivity in edible plants and animals that present a hazard to consumers or are harmful to aquatic life, as recommended by the Federal Radiation Council in the "Radiation Protection Guides";

(II) exceed 1/30 of the MPC values given for continuous occupational exposures in the National Bureau of Standards "Handbook No. 68", as revised; or

(III) exceed the current "National Primary Drinking Water Regulations" for waters used for public or domestic supplies.

(8) Toxic Substances:

(A) All effluents containing materials attributable to the activities of man shall be considered harmful and not permissible until acceptable bioassay tests have shown otherwise. At the request of the EQC, it is the obligation of the person producing the effluent to demonstrate that it is harmless.

(B) Compliance with paragraph (a) (4) of this section will be determined by use of indicator organisms, analysis of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the EQC.

(C) The survival of test organisms in discharge waters shall not be less than that for water from the same water body in areas unaffected by sewage, industrial wastes, or other activities of man, or, when necessary, for other control water that is consistent with the requirements for "Experimental Water" as described in "Standard Methods for the Examination of Water and Wastewater", latest available edition.

As a minimum, compliance with the standard as stated in the previous sentence shall be evaluated with a 96-hour bioassy or short-term method for estimating chronic toxicity. References for these methods are:

EPA/600/4-85/014 Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, December, 1985, or:

EPA/600/4-85/013 Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Cincinnati, Ohio, EMSL, March, 1985, or:

EPA/600/4-87/028 Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms, Cincinnati, Ohio, EMSL, May 1988.

(D) In addition, effluent limits based upon acute and/or chronic toxicity tests of effluents may be prescribed by EQC. Additional numerical receiving water limits including EPA's Section 304(a) criteria for Section 307(a) toxic pollutants as cited at 53 FR 177 and summarized in EPA 440/5-86-001 Quality Criteria for Water 1986, Washington D.C., OWRS, May 1, 1986, as amended by Update #1, September 16, 1986, and Update #2, May 1, 1987 ("Quality Criteria for Water") will apply. The numeric water quality standards from this reference are those for the parameters that are the Section 307 (a) priority pollutants. These standards are intended to protect both aquatic life and human health. For protecton of aquatic life, they are maximum levels not to be exceeded and EQC will utilize the national criteria guidance four-day average concentration limits or 24-hour average limits, whichever is most current, as standards. For protection of human health in fresh surface waters, the EQC will apply the national criteria guidance for ingestion through water and contaminated aquatic organisms as 30-day average limits. For other territorial waters, the EQC will apply the national criteria guidance for ingestion through contaminated aquatic organisms alone as 30-day average limits. For those priority pollutants that are carcinogens, the 10 to the minus sixth power risk level will be used.

(E) Maximum allowable pesticides concentrations for pesticides not covered under 24.0207 (a)(8)(D) shall also conform to national guidelines as stated in the "Quality Criteria for Water".

(9) There shall be no changes in basin geometry or freshwater inflow that will alter current patterns in such a way as to adversely affect existing biological populations or sediment distribution.

(10) Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works, highways, subdivisions, private developments, and recreational, commercial, or industrial developments, or the cultivation and management of agricultural lands, shall not enter any water of the territory. This standard shall be deemed met upon a showing that the land on which the erosion occurred or is occurring is being managed in accordance with soil conservation and control practices approved by the Soil Conservation Service, Director of the Land Grant Program, and Manager of the American Samoa Coastal Management Program.

(11) To protect estuarine organisms, no change in channels, basin geometry, or freshwater influx shall be made which would cause permanent changes in existing isohaline patterns of more than 10 percent.

(12) Total residual chlorine in discharge waters shall not exceed 20 micrograms per liter.

(b) Fresh surface waters. The following standards apply specifically to all fresh surface waters of the territory:

	Parameter	Median Not to Exceed the the Given Value
(1)	Turbidity (NTU)	5
(2)	Total phosphorus (micrograms P per liter)	150
(3)	Total nitrogen (micrograms N per liter)	300
(4)	Total suspended solids (milligrams per liter)	5

(5) Dissolved oxygen: Not less than 75% saturation or less than 6.0 milligrams per liter. If the natural level of dissolved oxygen is less than 6.0 milligrams per liter, the natural level shall become the standard.

(6) pH: The pH range shall be 6.5 to 8.0 and be within 0.5 pH units of that which would occur naturally except for the fresh water lakes on Aunu'u Island, where the minimum pH can be 6.0.

Sect 24.0207

(c) Pago Pago Harbor. The following standards apply specifically to Pago Pago Harbor:

	Parameter	Median Not to Exceed the Given Value
(1)	Turbidity (NTU)	0.75
(2)	Total phosphorus (micrograms P per liter)	30
(3)	Total nitrogen (micrograms N per liter)	200
(4)	Chlorophyll a (micrograms per liter)	1.0
(5)	Light penetration depth (feet) (To exceed given value 50% of the time)	65

(6) Dissolved oxygen: Not less than 70% saturation or less than 5.0 milligrams per liter. If the natural level of dissolved oxygen is less than 5.0 milligrams per liter, the natural level shall become the standard.

(7) pH: The pH range shall be 6.5 to 8.6 and be within 0.2 pH units of that which would occur naturally.

(d) Embayments. The following standards apply specifically to embayments excluding Pago Pago Harbor, Fagatele Bay, and Pala Lagoon.

	Parameter	Median not to Exceed the Given Value
(1)	Turbidity (NTU)	.35
(2)	Total phosphorus (micrograms P per liter)	20
(3)	Total nitrogen (micrograms N per liter)	150
(4)	Chlorophyll a (micrograms per liter)	.50
(5)	Light penetration depth (foot) (To exceed given value, 50% of the time.)	120

(6) Dissolved oxygen: Not less than 75% saturation or less than 5.0 milligrams per liter. If the natural level of dissolved oxygen is less than 5.0 milligrams per liter, the natural level shall become the standard.

(7) pH: The pH range shall be 6.5 to 8.6 and be within 0.2 pH units of that which would occur naturally.

(e) Fagatele Bay and Pala Lagoon. The following standards apply specifically to Fagatele Bay and Pala Lagoon.

	Parameter	Median Not to Exceed the Given Value
(1)	Turbidity (NTU), Fagatele Bay only	.25
(2)	Turbidity (NTU), Pala Lagoon only	.75
(3)	Total phosphorus (micrograms P per liter)	15
(4)	Total nitrogen (micrograms N per liter)	135
(5)	Chlorophyll a (micrograms per liter)	.35
(6)	Light penetration depth (foot), Fagatele Bay only (To exceed given value 50% of the time.)	130

7) Dissolved oxygen: Not less than 80% saturation or less than 5.5 milligrams per liter. If the natural level of dissolved oxygen is less than 5.5 milligrams per liter the natural level shall become the standard.

(8) pH: The pH range shall be 6.5 to 8.6 and be within 0.2 pH units of that which would occur naturally.

(f) Open coastal waters. The following apply specifically to open coastal waters; INCLUDING YA'I COVE

	Parameter	Median not to exceed the given value
(1)	Turbidity (NTU)	.25
(2)	Total phosphorus (micrograms P per liter)	15
(3)	Total nitrogen (micrograms N per liter)	130
(4)	Chlorophyll a (micrograms per liter)	.25

(5) Light penetration depth (foot) (To exceed given value 50% of the time.) 130

(6) Dissolved oxygen: Not less than 80% of saturation or less than 5.5 milligrams per liter. If the natural level of dissolved oxygen is less than 5.5 milligrams per liter, the natural level shall become the standard.

(7) pH: The pH range shall be 6.5 to 8.6 and within 0.2 pH units of that which occur naturally.

(g) Ocean Waters. The following standards apply specifically to oceanic waters:

	Parameter	Median not to exceed the given value
(1)	Turbidity (NTU)	.20
(2)	Total phosphorus (micrograms P per liter)	11
(3)	Total nitrogen (micrograms N per liter)	115
(4)	Chlorophyll a (micrograms per liter)	.18
(5)	Light penetration depth (foot) (To exceed given value 50% of the time.)	150

(6) Dissolved oxygen: Not less than 80% of saturation or less than 5.5 milligrams per liter. If the natural level of dissolved oxygen is less than 5.5 milligrams per liter, the natural level shall become the standard.

(7) The pH range shall be 6.5 to 8.6 and within 0.2 units of that which would occur naturally.

(h) Addition and Revision. It is specifically recognized that the establishment of additional or revised numerical standards is likely as sufficient supporting data becomes available. (History: Rule 8-81, effective 16 June 82, S 6).

24.0208 Zones of Mixing

(a) Policy: Zone of Mixing

Human activities may result in the practical need to discharge pollutants through point sources into the waters of the territory. And, because of technological, economic and other factors, it may not always be feasible to achieve an effluent quality that equals or exceeds the standards established herein at the point of discharge. Therefore, subject to the prohibitions, criteria and procedures set forth below, alternate water quality standards may be defined by the EQC for certain parameters in the immediate vicinity surrounding the point of discharge. The area within which the alternate standards apply shall be a zone of mixing. All applicable water quality standards shall be met at the boundary of any zone of mixing.

It is the policy of the EQC that zones of mixing shall only be granted upon a finding that no other practicable means of waste treatment and disposal are available. Further, it is the policy of the EQC that zones of mixing shall be limited to the smallest area possible.

(b) Criteria: Zone of Mixing

A zone of mixing can only be granted by the EQC if the application and the supporting information clearly shows that all of the following conditions have been met:

(1) The beginning or continuation of the function or operation involved in a discharge by the granting of the zone of mixing is in the public interest; and

(2) The proposed discharge does not substantially endanger human health or safety; and

(3) Compliance with the existing water quality standards at the point of discharge would produce serious economic hardships without equal or greater benefit to the public; and

(4) Alterations generated by a proposed discharge do not disrupt the marine ecology of the receiving waters outside the zone of mixing;

(5) A zone of mixing shall not be granted for fresh surface waters, Pala Lagoon, Fagatele Bay, that portion of Pago Pago Harbor described in 24.0206 (c) (2) (C), or in those waters in Manu'a described in 24.0206 ((d)(2)(G). Those water quality parameters which are subject to zone of mixing are chlorophyll a, light penetration depth, nutrients, pH, temperature, turbidity, and fecal coliform. Furthermore, those water quality parameters which are subject to zones of mixing must conform to alternative within-zone limits determined by the EQC. Determination of effluent limits for toxic substances must comply with 24.0207 (a) (8)(A)-(E) and 24.0207 (a) (9); and

(6) The standards set forth in 24.0207 (a)(1)-(4) shall be met within a zone of mixing; and

18 zom

(7) The proposed discharge will not result in a lowering of water quality outside the zone of mixing so as to violate the standards of 24.0206 and 24.0207 as they may be applicable.

(8) Further, the following shall be considered by the EQC in determining whether to grant or deny a zone of mixing.

(i) Protected uses of the body of water;

(ii) Existing natural conditions of the receiving water;

(iii) Character of the effluent

(iv) Adequacy of the design of the outfall and diffuser system to achieve the desired dispersion and assimilation in the receiving waters; and

(v) other pertinent policies, plans or territorial agencies.

(c) Procedures to Apply for Zone of Mixing

(1) Every application for a zone of mixing shall be accompanied by a complete and detailed description of present conditions, how present conditions compare to standards, proposed alternate water quality standards within the zone of mixing, and other such information as the EQC prescribes.

(2) Each application for a zone of mixing shall be reviewed in light of descriptions, statements, plans, histories, and other supporting information as may be submitted upon the request of the EQC and the effect on the water quality standards established in 24.0207.

(3) A zone of mixing, or a renewal, shall be granted within the requirements of this section for the following time periods and conditons:

(A) If a zone of mixing is granted on the grounds that there is no technically and/or financially efficient means known or available for the adequate prevention, control, or abatement of the discharge involved, it shall be only until the necessary means of prevention, control, or abatement becomes practicable and it shall be subject to the taking of any substitute or alternative measures that the EQC may prescribe. No renewal of a zone of mixing granted under this section shall be allowed without a thorough review of known and available means of preventing, controlling of abating the discharge involved.

(B) The EQC may permit a zone of mixing for a period not exceeding 5 years subject to reopener in the triennial review of water quality standards.

(C) Every zone of mixing granted under this section shall include, but not be limited to, permittee requirements to perform effluent and receiving water sampling and testing as specified by the EQC and to report the results of each test to the EQC. A program of research to develop practicable alternatives to the methods of treatment or control in use by the permittee may be required as a condition of the granting of the zone of mixing.

(D) Any zone of mixing granted pursuant to this section may be renewed periodically for periods not exceeding 5 years, on terms and conditions which would be appropriate for the initial granting of a zone of mixing; provided, that:

(I) the applicant for renewal has met all of the conditions specified in the previously prescribed zone of mixing; and

(II) no renewal shall be granted except on application therefor. Any such application shall be made at least 120 days prior to the expiration of the current zone of mixing permit.

(E) The EQC, on its own motion or upon the application of any person, shall terminate a zone of mixing if, after a hearing, it is determined that:

(I) the water area outside the zone of mixing does not meet the standards applicable to that water as given in 24.0207; or

(II) the zone of mixing granted will unreasonably interfere with any protected uses of the water area; or

(III) any NPDES permit condition is not being met and the discharger has failed to take action to bring the effluent into compliance.

Such termination shall be made only after a hearing held by the EQC in accordance with Chapter 4.10 ASCA. Upon such termination, the standards of water quality applicable thereto shall be those established for the water as otherwise classified.

(F) Upon expiration of the period stated in the zone of mixing, the zone of mixing shall automatically terminate and no rights shall be vested to the permittee. If a renewal of a zone of mixing has been applied for as specified in subparagraph (c) (3)(D) of this section, the zone of mixing shall continue until the renewal is approved or denied by the EQC.

(G) Whenever an application is approved, water quality standards will be strictly enforced in the waters adjacent to the zone of mixing. Requirements for discharge permits shall be determined to assure compliance with the zone of mixing at the worst-case receiving-water mixing and transport conditions and to assure protection of adjacent waters.

(H) No part of shoreline or barrier or fringing reef shall be included in any zone of mixing.

(I) In the event of an emergency, a zone of mixing can be temporarily withdrawn, in accordance with procedures provided by law.

(J) The granting of a mixing zone shall be subject to approval by USEPA.

24.0209 Permit Required

No point or nonpoint source discharges, or treated or untreated sewage or wastes from other than natural causes, shall be allowed into fresh surface waters, embayments, open coastal waters, ocean waters, or groundwaters of the territory without application to, review by, and written permission from the EQC.

24.0210 Water Quality Certifications

(a) Water Quality Certification Issuance

(1) Water quality certifications will be issued by the EQC for any proposed activity that is found not to violate applicable water quality standards and Sections 301,302, 303, 306, and 307 portions of the Federal Clean Water Act. A water quality certification is required by Section 401 of the Clean Water Act of any applicant for a federal license or permit to conduct any activity, including, but not limited to, the construction or operation of facilities which may result in a discharge into navigable waters of the United States.

WQ Certification

(b) Procedures to Apply for Water Quality Certification

(1) Contents of application

21

An applicant for certification shall submit a complete description of the discharge involved in the activity for which certification is sought, with a request for certification signed by the applicant. Such description shall include the following:

(A) The name and address of the applicant;

(B) A description of the facility or activity, and of any discharge into terrioria1 waters which may result from the conduct of any activity including, but not limited to, the construction or operation of the facility, including characteristics of the discharge, and the location or locations at which such discharge may enter territorial waters;

(C) If applicable, a description of the function and operation of equipment or facilities to control discharges, including specification of the methods of control to be used;

(D) The estimated date or dates on which the activity will begin and end, and the date or dates on which the discharge(s) will take place;

(E) If applicable, a description of the methods and means being used or proposed to monitor the quality and characteristics of the discharge and the operation of equipment or facilities employed in the control of the proposed discharges;

(F) The EQC may require the submission of additional information after a certification application has been filed. If a certification application is incomplete or otherwise deficient, processing of the application shall not be completed until such time as the applicant has supplied the missing information or otherwise corrected the deficiency. The EQC shall notify the applicant, in writing, within sixty days of the submission of an application if an application is incomplete or otherwise deficient. A description of the type of additional information necessary to complete the application or correct the deficiency shall be included with such a written notice. Failure to provide additional information or to correct a deficiency shall be sufficient grounds for denial of certification. EQC must act on the application after receipt of a completed application.

(G) The applicant must notify the EQC, in writing, of changes which may affect the application and certification process immediately thereon such things are noted by the applicant.

(c) Water quality certification; notice and hearing. The EQC may, upon request, provide the opportunity for public hearing(s) to consider the issuance of water quality certification as specified in the Administrative Procedures (Chapter 10, ASAC) and Environmental Quality Act (Title 24, ASCA). The EQC shall inform the applicant, in writing, that such action has been taken.

(d) Contents of Water Quality Certification

(1) A certification made by the EQC shall include the following:

(A) The name and address of the applicant;

(B) A statement that the EQC has examined the application made by the applicant and other information furnished to the licensing or permitting agency and bases its certification upon an evaluation of all such information contained in such application which is relevant to water quality certification.

(C) A statement that there is reasonable assurance that the activity will be conducted in a manner which will not violate water quality standards of the Clean Water Act;

(D) A statement of any conditions which the EQC deems necessary or desirable with respect to the discharge or the activity that will affect water quality; and

(E) Such other information as the EQC may determine to be appropriate.

(2) If, after considering the complete application, comments received during the public comment period, the record of a public hearing if held and other information and data as the EQC deems relevant, should the EQC determine that applicable water quality standards will not be violated and the best practicable methods of control will be applied to a discharge which is the result of any activity including but not limited to the construction and operation of facilities, then the EQC shall so certify.

(3) The EQC may modify the certification prior to the issuance of the federal license or permit, after consideration of information presented by the applicant, licensing or permitting agency or other government agencies or interested parties.

(e) Water Quality Certification; Adoption Of New or Revised Water Quality Standards

(1) To the extent permitted by applicable law, all water quality certifications to be issued by the EQC shall require the licensing or permitting authority to revise the license or permit to include a clause in the license or permit advising the licensee or permittee that the license or permit shall be subject to amendment or modificaiton if and to the extent that existing water quality standards are made more stringent, or new water quality standards are adopted, by the EQC.

(2) Upon adoption or revision of water quality standards, the EQC shall notify the licensing or permitting authority and the licensee or permittee of the revised or newly-enacted water quality standards and shall request the licensing or permitting authority to amend or modify the license or permit, if and to the extent permitted by applicable law, to reflect the applicable water quality standards.

24.0211 Enforcement, Compliance and Water Quality Monitoring

(a) Enforcement Authority

Enforcement of this chapter shall be in accordance with the applicable provisions of the territorial Environmental Quality Act, 24.0101 through 24.0169 ASCA.

(b) Enforcement Policy and Determination of Compliance with Water Quality Standards

(1) All of the preceding water quality standards are applicable within all water classifications at all times, except within a zone of mixing granted by the EQC.

(2) Compliance with water quality standards at a particular point for conventional pollutants shall be determined utilizing at least four consecutive measurements over a time period of not less than three months or greater than 12 months or at a frequency determined by the EQC. For toxic substances, compliance shall be determined by a single confirmed sample.

(c) Water Quality Monitoring

The EQC shall maintain an ongoing receiving water monitoring program to be utilized to determine trends in water quality and whether water quality in general meets water quality standards. A report examining these trends will be issued on a yearly basis as required by the Federal Clean Water Act.

(d) Public Notice of the Safety of Water Bodies for Protected Uses

The EQC shall post signs and advise the public through the media of any waters that do not meet the fecal coliform standard or other applicable water quality standards that may influence body contact recreation and other protected uses of the water body.

EPA rec'd
10 SEP 1990

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799
OFFICE OF THE GOVERNOR
ENVIRONMENTAL PROTECTION AGENCY

In reply refer to:
Serial: 403

August 28, 1990

Janet Hashimoto
Oceans and Estuaries Branch
U.S. Environmental Protection Agency
Region 9
1235 Mission Street
San Francisco, California 94105

Dear Janet:

Attached is a description and results of a toxicity study recently completed in Pago Pago Harbor, American Samoa. I would appreciate your assistance in review of this data, recommendations on additional resource documents, and suggestions for further study, if warranted. You can contact me at (684) 633-2304 or fax (684) 633-5801. Thank you.

Sincerely,

Sheila Wiegman
Environmental Coordinator
American Samoa Environmental
Protection Agency

Attachment:

cc: Pat Young, USEPA

PAGO PAGO HARBOR TOXICITY STUDY

August, 1990

OBJECTIVE

To determine whether a public health threat exists due to toxic components in seawater, sediments, or fish tissue in Pago Pago Harbor, American Samoa.

STUDY DESIGN

Inner Pago Pago Harbor was targeted as the worst case due to poor circulation and flushing capacity. Ship traffic and mooring, several industries (tuna canneries, ship yard, and power plant), and nonpoint source pollution contribute to potential level of toxic components in this area. In order to account for seasonality, (only one season completed at present) the study is conducted as follows:

Seawater
2 sites - 2 seasons

Sediments
6 sites - 1 season

Fish Tissue
4 species, 2 tissues (liver, muscle) - 2 seasons.

The sites chosen are shown on Attachment 1. Seawater was tested at the two sites with greatest potential for contamination. Those are (1) inner most Pago Pago Harbor where oil pollution is concentrated and (2) in front of Satala Power Plant near the ship yard where both facilities discharge stormwater. Sediments were sampled by tube corer at six sites as follows:

2 samples - inner most Pago Pago Harbor
1 sample - power plant
1 sample - shipyard
1 sample - near cannery outfall
1 sample - in front of Marine Resources Office

Five species of fish were caught by line in inner Pago Pago Harbor. Tissues were composited to obtain adequate sample volume. These are:

Lupo - zooplankton feeders
Surgeonfish - algae eaters
Mullet - detritus feeders
Mojarra - infauna feeders
Snapper - benthic crustacean eaters

The media were tested for the following parameters.

Seawater - volatile organics, trace metals, PCBs, TPH

Sediments - volatile organics, trace metals, oil and grease, particle analysis, PCBs, hydrocarbons

Tissue: PCBs, trace metals, hydrocarbons, pesticides.

(Metals include As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, Ag)

STUDY FINDINGS TO DATE

The first season seawater and fish tissue and one time sediment sampling was completed in April and May, 1990. The second sample is scheduled for late September, 1990. The preliminary results are provided below.

1. Seawater

Both sites samples showed similar results. Volatile organics were below detection levels. Metals (mg/kg) were below detection levels except:

	Site 1	Site 4
Cr	0.033	0.030
Cu	0.08	0.09
Pb	0.059	0.044

Total petroleum hydrocarbons are less than 0.15 for site 1 and 0.25 for site 4. Results on PCBs were not yet reported. When compared to chronic marine water quality criteria, lead concentrations exceed the criteria by 100 times. Chromium is slightly below the criterium. No chronic marine criterium is available for copper, and the results are less than the acute marine criterium.

2. Sediments

Volatile organics and pesticides testing at all sites were below detection limits.

PCBs in mg/kg in the form of Arochlor 1260 were found at all sites except site 6. Other forms are Arochlor were less than detection level. The concentrations of Arochlor 1260 which resulted are:

	PCB Concentration
Site 1	0.13
Site 2	0.22
Site 3	1.9
Site 4	2.0
Site 5	1.5
Site 6	<0.10

Metal Concentrations (mg/kg wet wt) were:

Site	1	2	3	4	5	6
As	2.09	2.25	2.00	1.60	2.05	24.8
Cd	0.69	0.60	0.79	0.32	1.34	2.7
Cr	27.4	25.1	47.6	38.6	16.8	17.4
Cu	26.3	21.7	122.0	344.0	27.3	11.2
Pb	25.9	27.5	53.8	42.3	27.0	41.5
Hg	0.03	0.03	0.09	0.02	0.04	0.03
Ni	27.0	25.5	36.8	20.4	20.8	31.0
Ag	0.84	1.10	0.70	0.32	1.13	7.2
Zn	158.0	162.0	234	240.0	240.0	41.6

Particle size analysis was conducted and is included here as Attachment 2. As no standards or criteria are available for sediments, the water quality criteria for metals were compared to obtain a relative/rudimentary picture of the results for metals.

Site 1 - All concentrations wee the same or below that of other sites.

Site 2 - Same as Site 2

Site 3 - Cr, Cu, Pb, Ni, Zn were markedly higher as compared to other sites.

Site 4 - Cu, Pb, and Zn were relatively higher than other sites.

Site 5 - Cd, Ag, and Zn were relatively higher than other sites.

Site 6 - As, Cd, Pb, and Ni were relatively higher than other sites.

For oil and grease analysis, Sites 1, 3, 4 and 5 showed concentrations of 2,000 to 7,000 mg/kg (wet weight) with sites 3, 4, and 5 being highest.

Fish Tissue

Polynuclear aromatics, PCBs, and pesticides were below detection limits in fish tissue and muscle. Fish liver and muscle tissue showed the following metals concentrations (mg/kg wet weight).

Fish Liver

	1	5	7	8	9
As	0.52	0.37	0.79	0.60	0.27
Cd	0.4	1.3	0.4	0.4	0.3
Cr	2.3	5.5	19.1	44.1	11.7
Cu	5.8	5.5	19.2	3.0	11.7
Pb	1.6	1.4	2.1	3.6	0.7
Hg	0.46	0.06	0.05	0.12	0.23
Ni	1.9	1.2	4.8	11.6	2.4
Ag	0.7	0.7	0.7	0.4	0.4
Zn	75.6	32.9	53.9	45.7	195.6

Fish Muscle

	1	2	3	4	7
As	0.01	0.03	<0.01	<0.01	0.15
Cd	0.20	0.30	0.37	0.33	0.50
Cr	1.9	33.8	5.5	4.6	21.7
Cu	0.61	1.32	0.29	0.46	1.6
Pb	1.1	1.6	1.9	2.5	2.6
Hg	0.06	<9.91	9.95	0.08	0.02
Ni	1.3	11.8	3.1	4.1	8.1
Ag	0.26	0.45	0.15	0.13	0.6
Zn	9.3	16.5	23.0	12.2	18.6

These results were compared to the legal limits for hazardous metals and organic proirity pollutants in fish and fishery products.

DISCUSSION OF PRELIMINARY RESULTS

1. Seawater

Chromium and especially lead concentrations appear to be of concern. These sights were chosen due to activities in their area. Oil spills and discharges from sandblasting ships are the primary potential sources of these metals at the site. Lead may be a constituent of the paints sandblasted off ships at the Southwest Marine Railway. The spent sandblasting wastes can easily escape to harbor. Chromium is a trace constituent of sandblasting abbrasive concentration for each metal is equal to 100% and the others are then assigned accordingly. As expected, the closer the species feeds to the bottom, the higher the metal concentration is found in the tissues. See attached graphs.

Problems and Further Information Needed

1. Metals concentrations in petroleum products?

2. Interpretation of sediment data as no standards or criteria exist? No background data is available.

3. PCBs are evident in the sediments but not in fish. Is this of concern or will it be in the future?

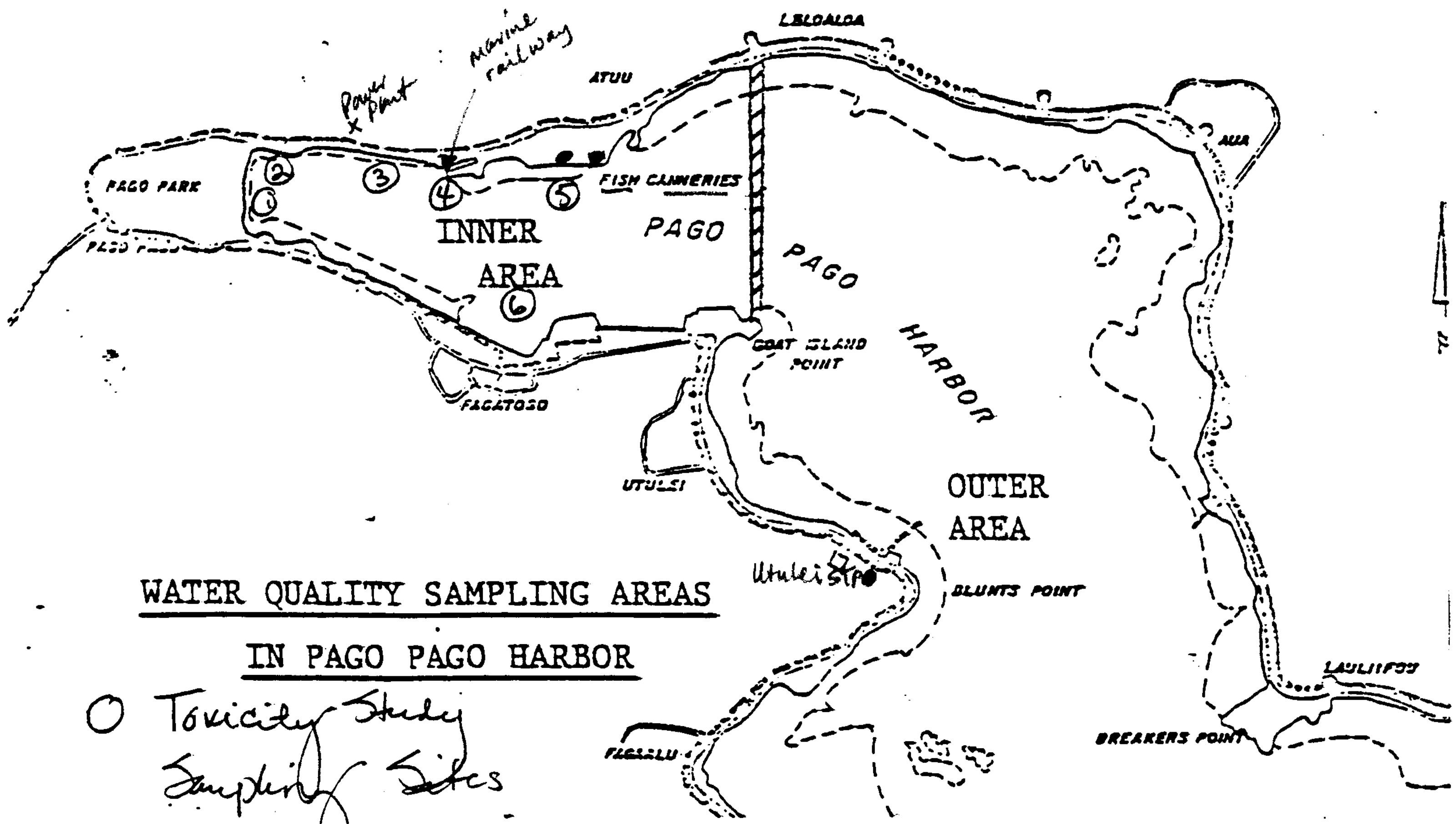
4. Chromium is found in seawater, shown to be relatively high in the sediments and to exceed the legal limit for fish tissue. How much of a concern is this?

5. Fish tissue is shown to exceed the minimum legal limit for most metals. How significant is this problem?

6. Risk assessment utilizing "Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual", USEPA, has not yet been completed. This will be completed in the future as soon as possible. Information from IRIS is necessary.

7. Do these results warrant issuance of a health advisory or prohibition on fish consumption in general or specifically?

8. What studies should be conducted that are further definitive and economically feasible? Is more study necessary?



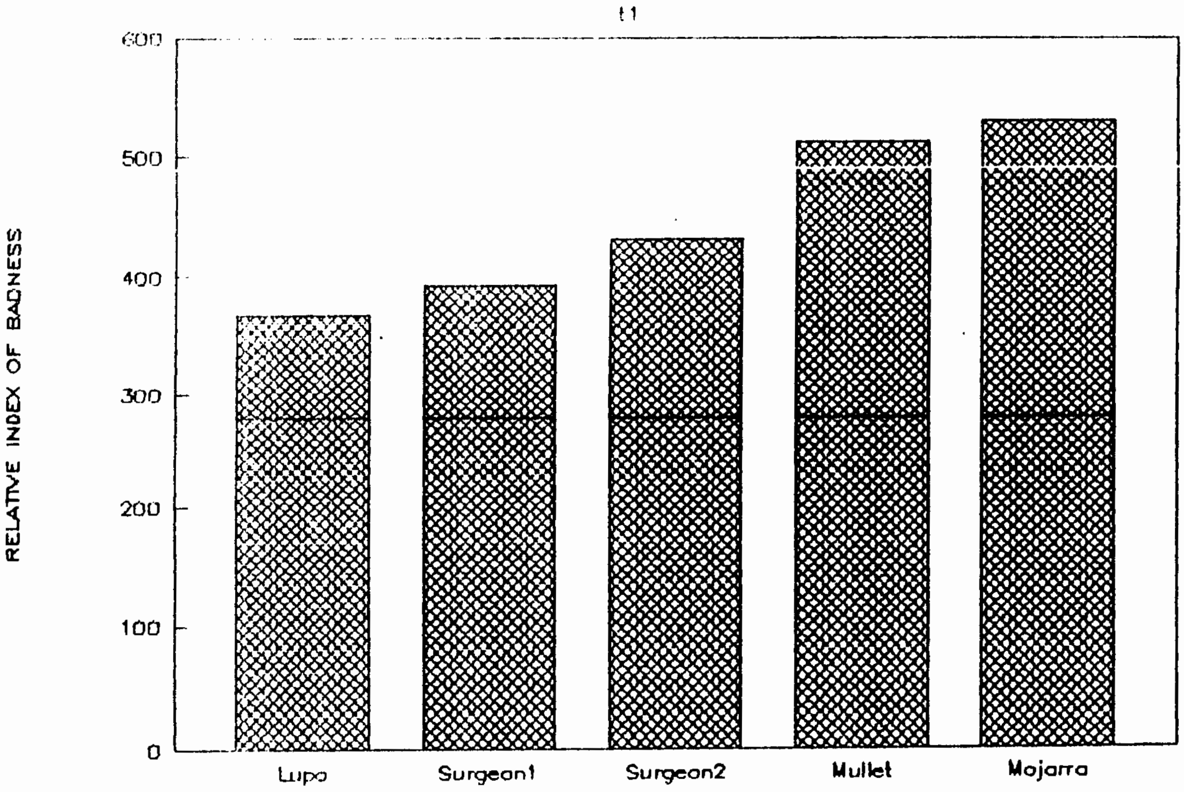
WATER QUALITY SAMPLING AREAS

IN PAGO PAGO HARBOR

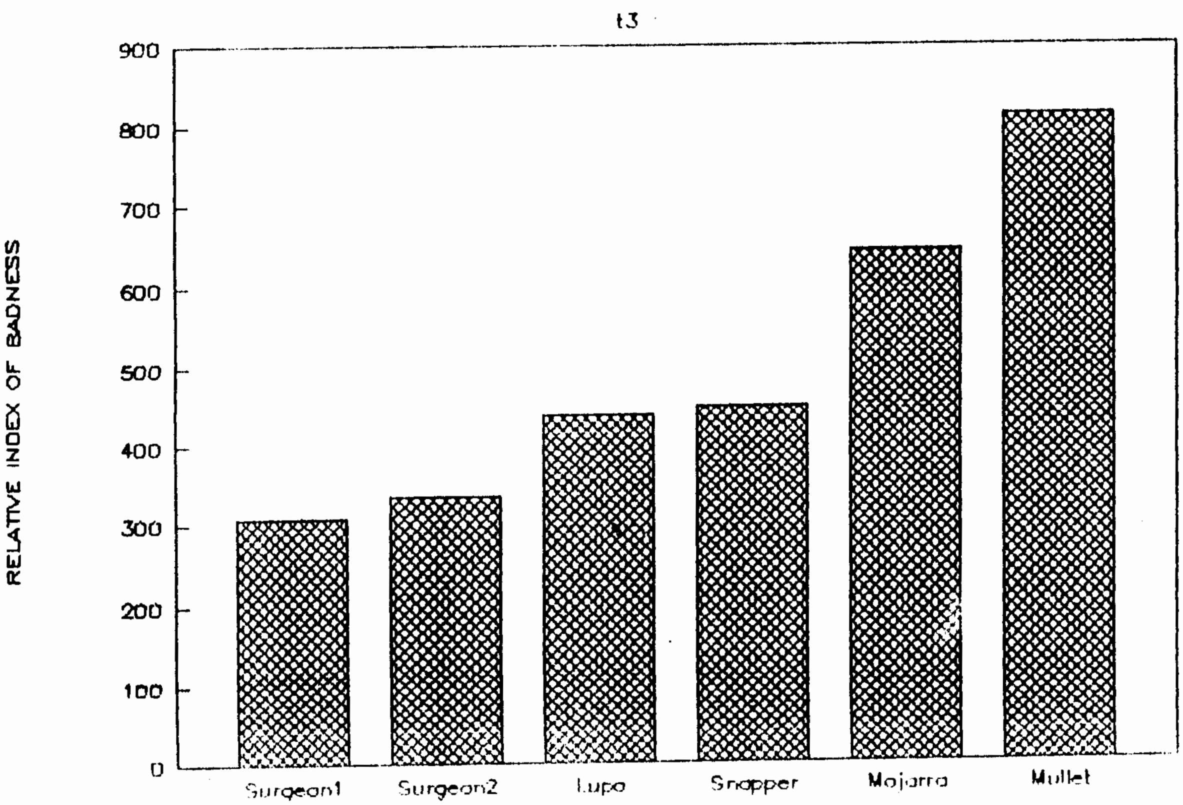
O Toxicity Study Sampling Sites

Attachment 1

FISH LIVERS -- HEAVY METALS LOAD



FISH MUSCLE -- HEAVY METALS LOAD



Attachment 2

PAGO PAGO HARBOR

SEDIMENT

GRAIN SIZE

(% in size fraction)							
(mm)	>2.0	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063
Site 1	-	8.1	17.0	1.4	27.2	22.8	23.5
Site 2	-	11.2	9.2	0.5	34.6	28.1	16.4
Site 3	2.1	5.1	8.1	2.4	49.4	26.3	6.6
Site 3D	0.1	0.6	1.9	11.4	18.8	13.4	53.8
Site 4	0.3	0.5	3.2	10.0	16.8	13.8	55.4
Site 5	0.5	10.9	29.5	12.8	35.3	15.9	5.0
Site 6	11.0	3.5	5.9	7.9	3.4	38.9	29.4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 9
1235 MISSION STREET
SAN FRANCISCO, CA 94103

June 1, 1990

Pati Faiai
Director
American Samoa Environmental
Protection Agency
Office of the Governor
American Samoa Government
Pago Pago, AS 96799

Dear Mr. Faiai:

This is in response to your May 21, 1990 letter requesting my office to review the need for a Waterbody Survey and Use Attainability Study as suggested in StarKist Samoa's comments to the proposed American Samoa Water Quality Standards, dated April 11, 1990.

StarKist asserts that the Environmental Quality Commission's determination that the existing water quality of Pago Pago Harbor does not fully support the existing protected uses of the harbor is based solely on qualitative observations. StarKist does not deny, however, that these protected uses are not impaired.

These existing protected uses include body-contact recreation, propagation and development of the marine ecosystem, and subsistence food gathering and fishing. Additionally, StarKist asserts that "the existing data for Pago Pago Harbor are insufficient in both quality (e.g. lack of QA/QC) and quantity (e.g. lack of specific data on marine life) to allow the American Samoa Government to bypass the waterbody survey and assessment..." StarKist suggests that the American Samoa Government apply EPA's water quality standards revision process as outlined in Figure 1 of EPA's "Water Quality Standards Handbook", in a "scientific manner" in order to support its assertion that existing protected uses are not being fully supported.

"Existing uses" as defined by 40 CFR Part 131.3(e) "...are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." There is no requirement that existing uses be "scientifically" determined. The determination of impaired uses over time, based on personal and/or historical observations is valid, and further documentation of the impairment by taking oral histories of longtime residents is suggested for the future. This information supports comparison between harbor water quality and quality in unimpaired waters as evidence of lack of full support of existing uses. In fact, at the hearing you conducted on the proposed standards, significant testimony was offered along these lines.

Designated uses are "those uses specified in water quality standards for each water body or segment whether or not they are being attained" [40 CFR Part 131.3(f)].

Regarding the need for a use attainability analysis (which includes a water body survey), the above-referenced water quality handbook states the following:

> In reviewing the standards on water quality limited segments, States must perform and submit to EPA a use attainability analysis if the States designates or has designated uses that do not include the uses specified in Section 101(a)(2) of the Act, or the State wishes to remove a designated use that is specified in Section 101(a)(2), or to adopt subcategories of uses specified in Section 101(a)(2) which require less stringent criteria than are currently adopted...
>
> ...No use attainability analysis is required when designating uses which include those specified in Section 101(a)(2) of the Act. [40 CFR Subpart B, Section 131.10 (j) and (k).]

Section 101(a)(2) of the Clean Water Act states ..."it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

Clearly, American Samoa's currently designated uses for Pago Pago Harbor include the uses specified in Section 101(a)(2). These uses are the same as existing uses and are not proposed to be changed. Therefore no actions are being considered which would require a use attainability analysis according to EPA regulations.

Appendix A of the Federal Register Notice promulgating the Final Rule of the Water Quality Standards Regulation (Vol. 48, No. 217, November 8, 1983), under "Resource Capabilities", clarifies that use attainability analyses "... apply only to water quality limited segments--segments where standards will not be attained even with implementation of technology-based controls of the Act, where the State wishes to justify uses less than 'fishable/swimmable.'" Again, the necessity of such an analysis is not applicable to the present situation in American Samoa.

Additionally, the regulations state that "States may not remove designated uses if: (1) They are existing uses, as defined in Section 131.3, unless a use requiring more stringent criteria is added; or (2) Such uses will be attained by implementing effluent limits required under Sections 301(b) and 306 of the Act and by implementing cost-effective and reasonable best management practices for nonpoint source control." Therefore there is no justification for performing a use attainability analysis on this basis.

While EPA regulations do not require the EQC to conduct a use attainability analysis for the present revision of water quality standards, the dischargers are not precluded from conducting such a study for the EQC in the future, should they have serious concerns regarding the attainability of protection and propagation of fish, shellfish and wildlife and recreation in Pago Pago Harbor. Under these circumstances, the dischargers must establish that a designated use never existed and is not attainable.

Should you wish to discuss this matter further, please contact Pat Young at (415) 556-5069 or Phil Woods at (415) 705-2177.

Sincerely

Norman L. Lovelace
Chief, Office of Pacific Island
and Native American Programs

cc: Phil Woods, W-3-1

SUMMARY OF COMMENTS PRESENTED AT APRIL 11, 1990, PUBLIC HEARING ON AMERICAN SAMOA WATER QUALITY STANDARDS, RESPONSE TO THE COMMENTS, AND CHANGES TO THE PROPOSED STANDARDS

A public hearing was held on the revision of American Samoa Water Quality Standards (WQS) on April 11, 1990. The hearing, originally scheduled for February 13, 1990, was postponed due to the effects of Hurricane Ofa which occurred in early February, 1990. The comment period was from January 11 to April 14, 1990. Comments submitted, and response to comments as necessary, and changes to the WQS are presented here. Comments submitted verbally and in writing are summarized below.

Changes to the WQS are contained in the last section.

COMMENTS

Star-Kist Samoa

See comments and response in the following section.

Samoa Packing Co.

See comments and response in the following section.

Department of Marine and Wildlife Resources (DMWR)

Henry Sesepasara

Comments focus on water quality of Pago Pago Harbor, the impact on fish resources, and human use of these resources. These comments are based on professional judgment, common sense, and personal observations of the Director and staff over many years.

Previously, the harbor had clear blue water and live coral. Now, pollution from a number of sources can be observed. This includes oil spills, garbage, sediment load, algal blooms, cannery waste, and presumably an uncatalogible number of toxic substances.

Inner harbor water quality is seriously degraded and has no potential for mariculture due to cumulative impacts of pollution. Four fish kills have been observed in the past year. There is a reduction in traditional fishing use of the harbor because of pollution and that the fish has a petroleum off odor. A study has recently been initiated to determine whether these fish are safe for human consumption.

It would be folly to relax water quality standards at this time. The standards should be strengthened and enforced in order to improve the habitat for fish and restore the traditional subsistence use of the harbor area.

CHANGES TO PROPOSED WATER QUALITY STANDARDS

1. Microbiological Standards

   The proposed WQS in Section 24.0207(a)(5) state that the fecal coliform concentration shall not exceed a geometric mean of 200 per 100 ml....nor shall any sample exceed 400 per 100 ml in more than ten percent of the samples. The fecal coliform standard will be restored to the original at 100 per 100 ml....nor shall any sample exceed 200 per 100 ml. This decision was determined based on input from the U.S. Environmental Protection Agency showing that the basis for the change was not fully justified.

2. Policy of Water Quality Degradation

   Section 24.0202(e) has been amended since the proposed WQS were made available for public comment. The proposed standards cite the variance procedure contained in the Environmental Quality Act as the procedure to be utilized for permitting degradation. The U.S. Environmental Protection Agency provided the EQC with updated information on permitting of degradation. This information, "Guidance on Implementing the Anti degradation Revisions of 40 CFR 81.12, U.S. Environmental Protection Agency," Region 9, June 3, 1983, has now been incorporated into this section.

3. Toxic substances and Initial Dilution

   The term "initial dilution" has now been deleted from section 24.0207(a)(2)(c) in order to conform with the criteria contained in the section in the WQS on Zone of Mixing.

Citizens

David Snow

A DMWR employee who is responsible for children's education programs is concerned for the wasteful and degraded condition of Pago Pago Harbor. He states this situation is difficult for the children to understand. The words "treated waste" in beautiful Pago Harbor are inherently conflicting and confusing to the kids.

David Herdrich

He supports the existing water quality standards and states that these are necessary as the harbor is obviously contaminated by oil slicks, solid waste, and fish processing wastes.

This citizen states that his observations are not unscientific because they are qualitative rather than quantitative. Both qualitative and quantitative observations are scientific as long as they are based on empirical observation. Observation of numerous Samoans and early explorers tell us Pago Pago Harbor was clear and teeming with fish and coral life such that you could see the bottom of the harbor even in the deepest areas.

Empirical observations of the commenter and numerous others tells you the harbor is green and you can no longer see the bottom. The only time he swam in Pago Pago Harbor he was covered with oil. Other evidence is seen in fish kills, oil slicks, and solid waste. The canneries, ships, and people are the source of these wastes.

Karla Kluge - Edmonds

She works at DMWR and has had the opportunity to witness the many forms of pollution to Pago Pago Harbor and the effects of the deteriorating water quality has had on the marine life within it. She has responded to fish kills in which the cause is not yet determined. People continued to eat this fish and participate in recreational activities. The causes of the fish kills are difficult to determine due to the many sources of pollution to the harbor. The major source which affects marine life and ultimately the human population is the canneries they should clean up the mess they helped to create.

RESPONSE TO COMMENTS

Samoa Packing Company (SPC)

COMMENT 1

SPC requests an increase in the total nitrogen (TN) parameter for Pago Pago Harbor from the proposed 200 mcg per liter to 300 mcg per liter and an increase in total phosphorus (TP) and from the proposed 30 mcg per liter to 42 mcg per liter for total nitrogen (TN). This is based on the amount they state they state they can meet and a reasonable engineering safety factor of 20%. The designated uses for Pago Pago Harbor would not be interfered with at these levels.

COMMENT 2

Existing data for Pago Pago Harbor are insufficient in both quality (e.,g. lack of QA/QC) and quantity (e.g., lack of specific data) to bypass the waterbody survey and assessment suggested by USEPA guidance documents.

Response

All existing data on Pago Pago Harbor were reviewed in this standards revision process and deemed adequate to determine where standards are being violated and to develop a water quality model for nutrients. Data and information utilized to complete the review of WQS include:

1. Monthly data on Pago Pago Harbor and streams accumulated between February, 1984 and December, 1988.

2. Data contained in the Joint Cannery Study.

3. Quarterly data on Pago Pago Harbor in conjunction with the Utulei Sewage Treatment Plant federal discharge permit, 1988 to 1990.

4. Data contained in the Soil Erosion Model for Pago Pago Harbor, 1985.

5. Fish kill occurrence.

6. Algal bloom observance.

7. Historical inputs to Pago Pago Harbor.

Figure 1, WQS Review and Revision Process, from the Water Quality Standards Handbook was utilized. The EQC determined in conjunction with USEPA Region 9 that adequate data on water quality are available, designated uses are appropriate, and the cause of the standards not being attained and the cause of use impairment is known. Further documentation was not considered necessary. Data QA/QC is adequate. The ASEPA lab is certified by USEPA, lab personnel here received ongoing training, and analysis for nutrients is completed off-island by AECOS, a well qualified laboratory also used by Star Kist. See attached letter from USEPA on the need for a water body survey/use attainability study.

Response

The EQC cannot grant an increase in TN and TP levels for Pago Pago Harbor as existing water quality does not support the protected uses of the harbor at this time. Any increase in these parameters is considered degradation of water quality and local and federal law prohibit such degradation unless an action undergoes careful scrutiny and documentation. A public review process is also required.

COMMENT 2

The EQC should further investigate all sources of nitrogen and phosphorus inputs to Pago Pago Harbor.

Response

The existing water quality monitoring program includes sampling for nutrients in a number of streams. Concentrations in streams show stable, but not necessarily low values for nutrients. Other point sources of concern include the Utulei Sewage Treatment Plant (STP) and sewage from yachts and ships discharged to Pago Pago Harbor. Monitoring related to the Utulei STP reveals that while the TN and TP contributions are substantial, the location of the outfall makes these discharges less of a problem. Nonpoint sources are wide ranging and difficult to catalog. For Pago Pago Harbor, this would include leaching from septic tanks and organic contributions related to surface runoff. Nonpoint source loadings to Pago Pago Harbor are predicted on the Soil Erosion Model for Pago Pago Harbor (Kennedy/Jenks/Chilton) and are directly related to the type of land use and development. This information was utilized in the Wasteload Allocation (WLA) Study. (HRI, 1989) The American Samoa Government (ASG) is implementing a Nonpoint Source Management Program to address these nutrient inputs to Pago Pago Harbor. The Soil Conservation Service and American Samoa Coastal Management Program address erosion control for new construction projects and farmers. ASG makes some efforts to curb other sources of nutrient input to the harbor, but additional work is necessary. See Comment 6 for Star Kist below.

COMMENT 3

It may be necessary for the EQC to determine a total maximum daily load or supplemental waste load allocation for Pago Pago Harbor.

Response

This may be required depending upon the ultimate waste disposal scenario chosen by the canneries. If both canneries implement high strength waste segregation and/or discharge outfalls beyond Pago Pago Harbor, this will not be necessary. If both canneries discharge in outer Pago Pago Harbor, the loading must be determined such that the WQS will continue to be met.

COMMENT 4

Ambiguous language is contained in Section 24.0208, Zone of Mixing,in the WQS as follows:

a) Section 24.0208(c)(3)(E)(II). A zone of mixing can be revoked based upon interference with a "probable" protected use. The word "probable" should be deleted.

b) Section 24.0208(c)(3)(G) Is the worst case receiving water mixing and transport condition based on modelling or actual experience?

Response

a) The word "probable" has been deleted from Section 24.0208.

b) Section 24.0208(c)(3)(G) refers to factors considered in determination of a zone of mixing and conditions for determination of compliance with the zone of mixing. In determining the dimensions of a zone of mixing, modelling that includes worst case receiving water mixing and transport is utilized. Actual measurements are utilized in conjunction with the modelling. Compliance determination requires actual measurements in the water body at the edge of the zone of mixing and beyond.

Star Kist Samoa

COMMENT 1

ASG did not utilize a scientific process in review of whether designated uses in Pago Pago Harbor are being attained. Proper USEPA guidance documents were not utilized. Star Kist states that "use impairment may be partially due to the navigation of ships in out of the harbor and the inherent danger associated with this use."

Response

ASG used the USEPA guidance available on water quality standards revision, Water Quality Standards Handbook and Guidance for State Waste Monitoring and Wasteload Allocation Programs. Throughout the revision process, USEPA expert personnel in Region 9 were consulted. ASG followed all USEPA directives and legal requirements.

Each type of protected use of Pago Pago Harbor will not necessarily occur at the same time and place. The Star Kist comment that ship navigation in Pago Pago Harbor may preclude some uses at some locations is true, but it is possible for most uses to be accommodated in Pago Pago Harbor at the same time.

COMMENT 3

Similar uses are attained in Pearl Harbor with less stringent numerical criteria. There is no scientific correlation between the protected uses and the numerical criteria for Pago Pago Harbor.

Response

Star-Kist did not list the uses that are attained in Pearl Harbor. A review of those uses reveals that the uses are similar. In addition, the State of Hawaii states that no new discharges, municipal or industrial, will be authorized for Pearl Harbor except noncontact thermal cooling and dry dock discharges. Star Kist does not provide any information as to the types of other discharges allowed or maintained in Pearl Harbor nor that the water quality criteria at this site is correlated to the beneficial uses. No information other than the water quality criteria is provided to show the similarity between Pago Pago Harbor and Pearl Harbor. It would be difficult to compare standards for Pearl Harbor and Pago Pago Harbor due to their physical and environmental differences. Pearl Harbor has large shallow areas, there is less effective flushing action than in Pago Pago Harbor, and Pearl Harbor waters have historically been turbid.

The American Samoa Water Quality Standards are based on the Baseline Water Quality Survey, U.S. Army Engineer District, Honolulu, 1979. Testing was completed that provided a picture of water quality at that time. Standards were promulgated based on the existing uses and existing water quality. Cannery input was sought and included oat the time of promulgation. Influence of the cannery discharges on TN and TP was documented and accounted for as the WQS ultimately promulgated were based on water quality of that time. While it is true that cannery discharges were less at that time, the amount discharged was still significant.

COMMENT 4

Numerical criteria for Pago Pago Harbor utilizing a median is not contained in the Baseline Water Quality Survey, American Samoa, 1979 as stated by the ASG.

Response

The Baseline Water Quality Survey data was utilized to derive the median values contained in the existing WQS. The median contained in existing and revised WQS was included in the WQS as a result of input from the canneries, the public, and ASG personnel and consultants in 1980 to 1983 when these WQS were first promulgated. Cannery records from this period should reflect on the events at that time.

COMMENT 5

The data base utilized to determine the numerical criteria for Pago Pago Harbor varies in size at each sampling station. How did ASG determine which data were used or were all data used? If all data were used, then the calculations could be skewed in the direction of those sampling stations with the largest individual data base.

Response

All available data were utilized to complete the 1989 WQS revision process. See Comment 2 above. For the period of 1984 to 1989, the data bases from ASG monthly sampling and the Joint Cannery Study contained the same number of data points for each station in Pago Pago Harbor.

COMMENT 6

Other sources contribute to the existing water quality condition in Pago Pago Harbor. Pago Pago stream #1 and #2 are in chronic violation of the proposed numerical criteria for Pago Pago Harbor. No specific plan has been developed by ASG to control these sources. ASG's plans for addressing nonpoint source pollution are vague and unacceptable.

Response

ASG does not deny other sources contribute to the existing water quality condition in Pago Pago Harbor. Some of this is natural variation, and some is related to the activities of men. Nutrient concentrations in streams are decreased through sewerage, proper septic tank construction, adequate control and treatment of livestock wastes, and best management practices for construction and agriculture. ASG has completed a Nonpoint Source Pollution (NPS) Management Program that has been approved by USEPA to increase activities to prevent NPS pollution. Star Kist failed to review this program prior to assertion of the above comment. In this comment, Star Kist incorrectly applied the water quality criteria for Pago Pago Harbor to streams. Streams fall under a different set of criteria. The influx of nutrients from surface runoff and streams was accounted for in the original promulgation of the WQS. The Soil Conservation Service has recently become active in American Samoa and decrease of nutrient inputs related to erosion are expected. Other initiatives exist within ASG that address these pollution sources, including programs of the American Samoa Power Authority, the Division of Public Health, and the American Samoa Coastal Management Program. See Comment 2 for Samoa Packing in the preceding section.

COMMENT 7

ASG data show that numerical criteria in open coastal waters at Station 5 have been exceeded for total nitrogen and total phosphorus in the past. The cause of these exceedences has never been evaluated or determined on a specific basis. Possible causes are: 1) natural conditions 2) point source discharge in the inner harbor through tidal water and open coastal waters, 3) nonpoint source discharges to the harbor and open coastal waters; or 4) combinations of the above. Relocation of the cannery outfalls to the outer harbor would result in continuing violation of WQS.

Response

It is highly likely the reason for the exceedence of TN and TP just beyond the mouth of Pago Pago Harbor are related to the cannery discharges and nonpoint source discharges. If the cannery outfall was relocated to the outer harbor and the waste disposal scheme included high strength nutrient waste segregation, potential for exceedence of standards beyond the harbor mouth will be lessened. Also, studies for a mixing zone and for field dispersion will provide further insight into the likelihood of such violations.

COMMENT 8

The use of the terms initial dilution and mixing zone is ambiguous. The definition of mixing zone should apply to toxic substances, coliforms, and all other numerical criteria at the boundary of the mixing zone.

Response

The term initial dilution has now been deleted from Section 24.0207 (a)(8)(c). The term initial dilution is not present in the WQS, thus the ambiguity between initial dilution and mixing zone has been removed.

COMMENT 9

Errors in the historical water quality data base were found which casts doubt on the scientific data base used to develop the WQS.

Response

In its assessment of the historical water quality data, Star-Kist utilized a computer printout received from the EQC which summarized water quality data from 1984 to 1987 which may have contained errors due to data entry. This printout was given to Star Kist as a courtesy for ease of review. However, the 1981 WQS were derived from the data contained in the Baseline Water Quality Survey of 1979 and the 1989 WQS revision was completed using the actual data sheets from 1984 to 1988, not the printout. Please see Comment 3 above regarding the derivation of the WQS.

COMMENT 10

What methodologies are recommended or approved by ASG for determining appropriate numerical criteria? Which were used by ASG during the 1989 triennial review process?

Response

The methodologies recommended and used by ASG to determine appropriate numerical criteria include a) review of historical data base of water quality; 2) data on inputs to Pago Pago Harbor and other water bodies from discharge monitoring reports and past studies; 3) records of fish kills and oil and other materials discharged; 4) data and professional judgment of marine biologists and water quality personnel; 5) historical reports of American Samoa residents, 6) comparison of data and trends with existing standards and c) modelling of Pago Pago Harbor and its watersheds for erosion and nutrient wasteload assimilation.

COMMENT 11

How are WQS violations determined?

Response

WQS violations are determined as outlined in Section 24.0211(b) of the proposed WQS.

BACKGROUND ON 1990 REVIEW OF WATER QUALITY STANDARDS FOR AMERICAN SAMOA AND ADOPTION OF THE WASTELOAD ALLOCATION STUDY FOR FAGO FAGO HARBOR

Introduction

The 1990 triennial review of Water Quality Standards (WQS) for the Territory of American Samoa will be summarized here. This review is completed to fulfill requirements of the federal Clean Water Act and to determine adequacy of existing WQS to protect and maintain the beneficial uses of American Samoa waters. The changes that were made are listed below. The public notice and adoption of these standards has been delayed due to the decision of the American Samoa Environmental Quality Commission (EQC) to complete the Wasteload Allocation Study for Pago Pago Harbor (WLA Study). This resulted from an issue raised by the canneries that the National Pollutant Discharge Elimination System (NPDES) permits issued has now been completed and will be subject to public notice and comment during the same period as the WQS. The study will be adopted by the EQC pending the public comment period.

WQS Changes

1. Organization

   The organization of the WQS and a number of their provisions have been reviewed and changed to be more fully inclusive. Several sections have been split up and sections on Water Quality Certification and Compliance and Monitoring have been added. Descriptions of Pago Pago Harbor and Pala Lagoon are now found in the Definitions Section. These changes allow for streamlining and further clarity in the regulations.

2. Groundwater

   A specific section on ground waters, Section 24.0206, has been added to provide additional protection for American Samoa aquifers. Potential for their contamination has increased due to development pressures in the Tafuna-Leone area where the major aquifer is located. Contamination resulting from cesspools and poorly constructed septic tanks has been previously documented.

3. Toxic Substances

   More specific provisions on monitoring and assessment for presence of toxic substances in American Samoa waters has been included. These provisions also state the standards that will be utilized to determine the level of toxicity.

4. Standards of Water Quality

   This section provides protected and prohibited uses and qualitative and numerical standards for each water body classification.

The extreme standards (Value Not to Exceed 10% of the time and value Not to Exceed 2% of the Time) have been deleted for each water body classification. These standards have not been utilized in the past. It is not likely that these standards will be applied in the future due to the sampling regime and frequency feasible for monitoring programs in American Samoa.

Water quality data collected from 1984 to 1988 for Pago Pago Harbor was evaluated for trends and to determine whether existing WQS provide adequate water quality objectives (protected uses) for Pago Pago Harbor. analysis reveals that WQS for total nitrogen and total phosphorus are not met in the harbor. Modeling of the harbor done in the conjunction with the Joint Cannery Study (1986) and WLA Study (1989) shows that this results primarily from cannery waste discharged to the inner harbor. Local and federal efforts to encourage additional treatment or change of the point of discharge are underway.

Proposed changes in total nitrogen and total phosphorus WQS were evaluated in the WLA Study and for the triennial WQS review, and the EQC has determined that relaxation of these WQS is not warranted. Existing water quality does not support the existing protected uses of Pago Pago Harbor which include recreational and subsistence fishing, subsistence food gathering; support and propagation of marine life, maricultural development, and whole and limited body contact recreation. Relaxation of water quality standards will contribute to continued impairment of Pago Pago Harbor protected uses and delay in the recovery of the harbor water quality that supports the above stated protected uses.

5. Zones Mixing

All requirement and criteria for zones of mixing have been consolidated. The technical criteria is now more flexible to allow for case by case determination of mixing zones.

6. Water Quality Certifications

This section has been added as the EQC is more frequently required to issue water quality certification as required by Section 401 of Clean Water Act. These provisions are similar to such regulations in other territories.

7. Compliance Determine and Water Quality Monitoring

A specific procedure to determine compliance with WQS numerical WQS has now been included. Sections on water quality monitoring requirements and public notice on safety of water bodies are added.

Waste Load Allocation Study for Pago Pago Harbor

The EQC contracted for completion of the WLA Study in 1988 to determine the total maximum daily loading for Pago Pago Harbor. This determination is required under Section 303 of the Clean Water Act when effluent limitations are not stringent enough to implement a water quality standard applicable to those waters. In Pago Pago Harbor, nitrogen and phosphorus loading are the parameters in which WQS are exceeded on a chronic basis. analysis of water quality and hydrodynamic data, development of a Pago Pago Harbor model, and calculation of the total maximum daily load for total nitrogen and total phosphorus was completed in the WLA Study. The total maximum daily loading becomes the near equivalent of the wasteload allocation and is highly dependent on location of the tannery discharge within Pago Pago Harbor. This Study will assist in determination of schemes to improve Pago Pago Harbor.

AMERICAN SAMOA GOVERNMENT
PAGO PAGO, AMERICAN SAMOA 96799
OFFICE OF THE GOVERNOR
ENVIRONMENTAL QUALITY COMMISSION

PUBLIC NOTICE

DRAFT AMERICAN SAMOA WATER QUALITY STANDARDS AND WASTELOAD ALLOCATION STUDY FOR PAGO PAGO HARBOR

PUBLIC HEARING

The Environmental Quality Commission (EQC) has reviewed and revised the American Samoa Water Quality Standards (WQS) originally promulgated in 1981 and hereby provides notice to the public and all interested parties of the availability of draft revised American Samoa WQS. WQS are numerical and qualitative regulations developed to protect and maintain the beneficial uses of water bodies in American Samoa. The Wasteload Allocation Study for Pago Pago Harbor, American Samoa has been completed in fulfillment of Section 303 of the federal Clean Water Act. The inner portion of Pago Pago Harbor is considered a water quality limited segment, and the study was commissioned to determine the amount of nitrogen and phosphorus wastes that could be discharged to the harbor at the same time maintaining compliance with WQS.

A public comment period will be held from January 11 to February 28, 1990 in which comments will be received from the public and any interested parties at the address listed below. Copies of the draft regulations are available at the Office of the American Samoa Environmental Protection Agency (ASEPA) located at the Convention Center in Utulei. The Wasteload Allocation Study can be reviewed at the same location. You may contact Sheila Wiegman of ASEPA at (684) 633-2304 for any questions.

A public hearing will be held February 13, 1990 at 4:00 p.m. at Tapa Room, Rainmaker Hotel in which the public and interested parties may present comments on the draft WQS. Comments must also be submitted in writing no later than 4:00 p.m. February 28, 1990 .

Executive Secretary
Environmetnal Quality Commission
Office of the Governor
Pago Pago, American Samoa 96799

Sheet

ENVIRONMENTAL QUALITY COMMISSION

PUBLIC NOTICE

The Environmental Quality Commission (EQC) hereby notifies the public and interested parties that the public hearing on draft revised Water Quality Standards (WQS) and the Wasteload Allocation Study for Pago Pago Harbor scheduled for February 13, 1990 cancelled due to the effects of Hurricane Ofa will be held on Wednesday April 11, 1990 at Sadies Restaurant Conference Room at 4:00 p.m.

Testimony on the draft WQS will be accepted at that time. Written comments on the draft regulations and Wasteload Allocation Study for Pago Pago Harbor will be accepted until the close of the business day on April 11, 1990 and should be mailed to:

Executive Secretary
Environmental Quality Commission
Office of the Governor
Pago Pago, AS 96799

or at the Office of the American Environmental Protection Agency, Convention Center, Utulei. Draft documents are also available there. You may contact Sheila Wiegman at 633-2304 for any questions.

Sheila W

Pati Faiai
Executive Secretary
Environmental Quality Commission

Two days
3/22/90
&
3/28/90

OFFICE OF THE GOVERNOR
ENVIRONMENTAL QUALITY COMMISSION

PUBLIC NOTICE

POSTPONEMENT OF PUBLIC HEARING ON WATER QUALITY STANDARDS AND PAGO PAGO HARBOR WASTELOAD ALLOCATION STUDY

The Environmental Quality Commission hereby announces that the public hearing to be held on the revised draft American Samoa Water Quality Standards and the Pago Pago Harbor Wasteload Allocation Study on February 13, 1990 is postponed until further notice due to the effects of the storm Ofa. Written comments on the standards and the study will be accepted until close of the public hearing to be announced in the near future. You may contact Sheila Wiegman at 633-2304 for any questions.

Executive Secretary
Environmental Quality Commission

AECOS 609

DRAFT

A Preliminary Toxicity Study of Water, Sediment, and Fish Tissues from Inner Pago Pago Harbor in American Samoa

Prep. By:

AECOS, Inc.
970 N. Kalaheo Ave., Suite C311
Kailua, Hawaii 96734

Prep. For:

The Government of Americam Samoa
The Department of Marine and Wildlife Resources
American Samoa Environmental Protection Agency
American Samoa Coastal Management Program

July 1991

I. INTRODUCTION

This report presents a discussion of analyses on samples of seawater, harbor sediment, and fish tissues from Pago Pago Harbor, Tutuilla Island in American Samoa. The study was jointly sponsored by the American Samoa Coastal Management Program (ASCMP), the Department of Marine and Wildlife Resources (DMWR), and the American Samoa Environmental Protection Agency (ASEPA). The purpose of the sampling and analyses was to determine whether toxic chemical compounds could be detected in the marine environment of the harbor, and provide a preliminary assessment of the extent of contamination and the risk to public health.

Some of the text of this report has been taken directly from a previous report entitled "Water and sediment quality assessment for pollutants in the Nu'upia Wildlife Management Area, Marine Corps Air Station, Kaneohe Bay" prepared by AECOS, Inc. in 1990. This study shared a similar purpose with the Pago Pago Harbor study and much of the general discussion concerning toxic substances in that report is directly relevant to the Pago Pago Harbor study.

A paucity of environmental data for toxic substance from American Samoa dictates the need to utilize data from other areas to "provide perspective" for the results of the present study. Hawaii is perhaps the best area for comparison because of the geological and climatological similarities between the Hawaiian Islands and the Samoan Islands. Although measurements of toxic substances in marine environments in Hawaii are not numerous, several important studies do exist.

Previous Studies in Pago Pago Harbor

Numerous water quality studies for Pago Pago Harbor have been conducted which include the measurement of nutrient content and other basic water quality parameters. However, only one earlier study could be found which included analyses for toxic substances in the harbor (ASEPA, 1974). The results from this study of six sediment samples are given in Table 1. The total residue values are of interest in so far as they provide an estimate of the water content of inner harbor sediments (around 55%). Two of the samples (off Standard Oil dock and off Utulei Plant) appear not to be sediment samples at all. The total residue of seawater would be on the order of 3 to 3.5 % (i.e., the salt content). Thus, the solids in these two samples would comprise less than 2 % of the weight. The volatile residue gives an estimate of the organic content of the sample.

Table 1. 1974 analyses of bottom samples from Pago Pago Harbor (1974).

Location	Residue Total %	Residue Volat. %	COD %	TKN ppm	Cr ppm	Cu ppm	Pb ppm	Hg ppm
Center of Upper Harbor	46.6	5.8	2.9	2,200	54	30	141	0.4
Off Canneries	44.0	4.2	1.8	5,300	58	38	110	0.4
Off Standard Oil Dock	5.2	1.5	--	--	Tr	3	10	0.1
Off Leloaloa	64.1	2.9	1.1	4,650	41	20	50	0.2
Off Utulei Plant	3.9	1.3	--	--	--	--	--	--
Off Ava Point	16.8	3.4	--	--	--	--	--	--

An environmental assessment of the impacts of proposed construction and dredging on the reef surrounding the Rainmaker Hotel (Utulei) prepared by AECOS (1985) included a sampling of water for soluble petrochemicals. Samples were analyzed by fluorometer, and the instrument response compared with diesel standards and spiked samples. Soluble petrochemicals were not detected at a limiting concentration of 0.075 ppm as diesel. A report by Kennedy Engineers (1964) included samples of water from the inner harbor which were analyzed for oil & grease, NFR, pH, and BOD. This single May 1964 sampling for oil & grease at three locations provided the following results:

Off Anua	23 mg/L
Off Autapini	160 mg/L
Off Pago Pago	131 mg/L

II. METHODS

The samples of seawater, sediment, and various fishes were collected by the program sponsors at six sites within Pago Pago Harbor on several occasions roughly representative of two seasons. These sites were all located in the inner harbor; within a line drawn across the harbor from Fagatogo on the south and Atuu Village on the north. The inner harbor includes the more developed industrial and commercial activities and has the poorest circulation and exchange with the open ocean of any part of Pago Pago Harbor. It is reasonable to assume that if toxic substances are concentrated anywhere, they will be found within the inner harbor.

Samples were shipped to AECOS, Inc. in Hawaii for processing and analyses (or redistribution to other laboratories for some analyses).

For consistency, all concentrations presented in this report are given in parts per million (ppm), which is milligram per kilogram (or ug/g) for sediments and milligrams per liter (or ug/ml) for solutions.

Fish Samples

Samples of fish tissues from fishes captured within inner Pago Pago Harbor were analyzed for heavy metals, pesticides, PCB, and PAH (polynuclear aromatic hydrocarbons). Fish species selected for testing adhered to the following criteria:

1. species that are commonly caught and eaten;
2. species likely to reside within the harbor rather than being transient
3. species that represent each of the following feeding groups: detritivòre, herbivore, and carnivore

The primary candidates from Pago Pago Harbor were the 'anae or mullets (Family Mugilidae) representing detritivores, the pone or surgeonfishes (Family Acanthuridae) representing herbivores, and the jacks (Family Carangidae) for carnivores. Additional species caught and analyzed included matu (<u>Gerres</u> sp., Family Gerreidae), an infauna feeder, and tamala (<u>Lutjanus</u> <u>fulvus</u>, Family Lutjanidae), which feeds on benthic crustaceans (Kluge-Edmonds, 1990). All of these fishes are commonly found in the harbor, and regularly caught and consumed by local residents. Some, however, may travel in and out of the harbor.

Fishes were frozen whole and shipped to Hawaii. While a single modest-sized specimen would usually provide sufficient muscle tissue for all of the analyses, batching was necessary to obtain a sufficient quantity of liver tissue for all of the tests. Batching of dissected tissue was undertaken in the laboratory and only fishes of the same species were combined into a batch. Because so many different collections were received by the laboratory and combined in various ways, we have attempted to simplify reporting of results by arbitrarily assigning batch numbers (Table 2) and referring to these in the data tables. Batch numbers are enclosed in brackets ("[]") These numbers do not correspond with either collection identification numbers (assigned by DMWR) or laboratory log numbers (assigned by AECOS, Inc.).

The initial sampling of fishes on 20 April 1990 consisted of two lupo (Urapsis sp.), one surgeonfish (Acanthurus xanthopterus), and two matu (Gerres sp.). A single tamala (Lutjanus fulvas) was caught on 24 April. All of these fishes were shipped and received at the laboratory on April 25 to be entered as Log No. 4167. Because this initial collection did not provide sufficient liver tissue, the collection was supplemented by additional catches made between 30 April and 6 May 1990. Shipped to the laboratory and received on 7 June (entered as Log No. 4457) were two 'anae (Family Mugilidae), eight acanthurids (Acanthurus xanthopterus), seven tamala (L. fulvus), five matu (Gerres sp.), and nine lupo (Urapsis sp.). The locations in Pago Pago Harbor where these fishes were caught is presented in Appendix Table D1 based on notes provided by DMWR.

A second sampling of fishes on or around October 10, 1990 were caught in front of DMWR (Fagatogo). These were grouped as follows: 1) 91 small mullet, 2) two (?) medium and one large mullet, and 3) ten acanthurids. These fishes were received on 11 October (entered as laboratory Log No. 4658). Many of the small mullet had thawed and the tissue deteriorated. Consequently, this sampling was supplemented by three more batches consisting of 1) 95 mullet, 2) 6 mullet, and 3) 9 acanthurids caught on or about 19 October 1990; then a supplemental sampling was made on October 30/November 1 of 1) 3 mullet and 7 acanthurids. These fishes were received frozen on 2 November and entered as laboratory Log No. 4699.

A third sampling was made 2-4 January 1991. This sampling provided 13 ga or mackerel (Rastrelliger kanagurta), 20 lai or jack (Scomberiodes lysan), and 15 acanthurids (surgeonfish; Acanthurus xanthopterus). These fishes were received 10 January and entered as Log No. 4782.

Table 2. Field and laboratory notes on fishes from Pago Pago Harbor supplied for tissue analyses.

No.[1]	Date Caught	Qty.	Type	Species	Log No.	Batch No.[2]
1	4/20/90	1	acanthurid	A. xanthopterus	4167	[1]
2	"	2	matu	Gerres sp.	4167	[2]
3	"	2	lupo	Urapsis sp.	4167	[3]
4	4/24/90	1	tamala	Lutjanus fulvus	4167	[4]
5	4/30-5/6	9	lupo	Urapsis sp.	4457	[5]
6	"	7	tamala	Lutjanus fulvus	4457	[6]
7	"	2	'anae	mullet	4457	[7]
8	"	5	matu	Gerres sp.	4457	[8]
9	"	8	acanthurid	A. xanthopterus	4457	[9]
1A	10/1/90	5	'anae	mullet	4658	[10]
1B	"	21	'anae	mullet	4658	[11]
1C	"	25	'anae	mullet	4658	[10]
1D	"	24	'anae	mullet	4658	[11]
1E	"	17	'anae	mullet	4658	[11]
2	"	3?	'anae	mullet	4658	[12]
3	10/10/90	10?	acanthurid	A. xanthopterus	4658	[13]
1	Oct/Nov	98	'anae	small mullet	4699	[11]
2	"		'anae	med./lg. mullet	4699	[12]
3	"	8	acanthurid	A. xanthopterus	4699	[13]
1	1/2-4/91	11?	acanthurid	A. xanthopterus	4782	[14]
2	"	18	lai	Scomberoides lysan	4782	[15]
3	"	15	ga	Rostrelliger kanagurta	4782	[16]

1 - Assigned by DMWR.
2 - Specimens combined into batch by laboratory

III. RESULTS

III.A. Heavy Metals

Metals comprise a major fraction of the earth's crust and are transported to the oceans by run-off and other natural processes. Over geological time, a steady state has established between the ocean and the crustal material of the earth (NAS, 1975). Various aspects of the natural occurrences of heavy metals are presented in Table 3.

Table 3. Metal content of the geo- and hydrosphere in the absence of obvious pollution (in part from Baudo and Muntau, 1990 and from Kennish ,1989).

	Mean Crust (mg/Kg)	Mean Soil Range (mg/Kg)	Freshwater Range (ug/L)	Seawater Range (ug/L)	Seawater Saturation (mg/L)
Ag	0.07	0.01-8	0.01-3.5	0.03-2.7	2.0-2.5
As	1.5	0.1-40	0.2-230	0.5-3.7	
Cd	0.11	0.01-2	0.01-3	<0.01-9.4	4-1000
Cr(III)	100	5-1500	0.1-6	0.2-50	high
Cu	50	2-250	0.2-30	0.05-12	0.4-0.8
Hg	0.05	0.01-0.5	0.0001-2.8	0.01-0.22	100-1000
Ni	80?	2-750	0.02-27	0.13-43	20-450
Pb	14	2-300	0.06-120	0.03-13	0.3-0.7
Zn	75	1-900	0.2-100	0.2-48	1.2-2.5

Sources: Bowen (1979); Dell'Aglio et al. (1986); Krauskopf (1956).

III.A.1. Heavy Metals in Sea water

Heavy metals appear as trace elements in ocean water (lower part of range in column 4, Table 3; note units are ug/L or ppb). Accurately establishing the concentration of most metals in open ocean waters has challenged chemical oceanographers for decades, and the published equilibrium concentrations have steadily declined with improvements in analytical techniques (for example, see Goldberg, 1965). Concentrations tend to be higher in coastal waters as a function of river and stream run-off, settlement of wind blown solids, and human activities.

In 1980, the U.S. Environmental Protection Agency (USEPA) presented guidelines for deriving water quality criteria for the protection of aquatic life and published a number of documents presenting the criteria for a variety of toxic materials. These criteria "are not intended to provide 100 percent protection of all species and all uses of aquatic life all of the time, but they are intended to protect most species in a balanced, healthy aquatic community" (USEPA, 1986, Appendix B). Revised criteria were presented in 1985 (see USEPA, 1987) for substances where sufficient acceptable toxicity data exists to establish an acute toxicity criterion which is presented as "the highest 1-hour average concentration that should not result in unacceptable effects on aquatic organisms and their uses." In some cases, this concentration is made a function of a water quality characteristic such as pH, salinity, or hardness. A chronic toxicity criterion is the highest 4-day average concentration that should not cause unacceptable toxicity during long-term exposure. If appropriate, this concentration is also related to a water quality characteristic.

The 1985 criteria are expressed as 1-hour (acute) or 4-day (chronic) average concentrations not to be exceeded "more than once every 3 years on average" -- wording clearly added for regulatory purposes involving discharges or accidental introductions (spills) to aquatic environments. The criteria provide a frame of reference based on EPA's accumulation and review of toxicity data. Thus, the "1-hour" and "4-day" average concentrations are not requirements that need be met to establish significance of the reported values.

In November 1989, the State of Hawaii, Department of Health presented amendments to Chapter 11-54 of the Hawaii Administrative Rules which included acute and chronic toxicity standards for all State waters. The standards, adopted in January 1990, cover a range of potentially toxic inorganic and organic substances and are based upon the EPA criteria (USEPA, 1987) discussed above. Thus, the State standards set different values for fresh and salt (marine) waters; and include "human health standards" (also described as "fish consumption" standards). The DOH salt water standards apply to all water bodies with greater than 0.5 ppt salinity (essentially estuarine as well as marine waters). For the heavy metals, the DOH standards (shown in Table 4) are generally the same as those established earlier by EPA. However, because the erosion of volcanic soils can contribute heavy metals to aquatic environments, the State adopted the EPA criteria where these standards appeared to be achievable; other standards (as yet to be established) will be based on the metals concentrations found in unpolluted Hawaiian environments (DOH, 1989). These standards are intended to be enforced through effluent limita-

Table 4. State of Hawaii, Water Quality Criteria for Heavy Metals (DOH, 1989). Values expressed as soluble fraction in mg/L (ppm).

Pollutant	Freshwater Acute	Freshwater Chronic	Saltwater Acute	Saltwater Chronic	Fish Consumption
Aluminum	0.750	0.260	ns	ns	ns
Antimony	3.000	ns	ns	ns	15.000
Arsenic	0.360	0.190	0.069	0.036	ns
Beryllium	0.043	ns	ns	ns	ns
Cadmium	0.003*	0.003*	0.043	0.0093	ns
Chromium (VI)	0.016	0.011	1.100	0.050	ns
Copper	0.006*	0.006*	ns	ns	ns
Lead	0.029*	0.029*	0.140	ns	ns
Mercury	0.0024	0.00055	0.0021	ns	ns
Nickel	0.005*	0.005*	0.075	0.0083	0.033
Selenium	0.020	0.005	0.300	0.071	ns
Silver	0.001*	0.001*	0.0023	ns	ns
Thallium	0.470	ns	0.710	ns	ns
Zinc	0.022*	0.022*	0.095	0.086	ns

* - Value listed is the minimum standard. Depending upon receiving water CaCO3 hardness, higher standards may be calculated using the respective formula in USEPA (1987).

ns - No standard yet developed.

tions or other conditions in discharge permits (the NPDES wastewater discharge permits program).

Sea water samples were collected from just below the surface at Pago Pago Harbor Sites 1 and 4 on 19 April 1990, and at the same sites on 2 October 1991. Results are summarized in Table 5. Included in this table are "baseline" or typical inner harbor sediment concentrations, the derivation of which is described in detail in Section III.A.2 below.

For arsenic, cadmium, mercury, nickel, and silver, concentrations in the sea water samples were below the detection limits for these metals. Only chromium, copper, lead, and zinc were detected in the samples. However, the levels of copper and zinc are within the ranges of observed adverse effects on marine biota as demonstrated by laboratory toxicity studies (recently summarized by Mance, 1987). Copper at 0.1 ppm can be fatal to a variety of marine invertebrates and invertebrate larvae, especially hydrozoans, annelids, molluscs, and crustaceans. The toxic effects of zinc are usually expressed at concentrations greater than 1.0 ppm, but chronic toxicity has been demonstrated in some molluscs at levels as low as 0.1 ppm. The toxicity of zinc has been shown to increase with increasing temperature and decreasing salinity in some estuarine species, including molluscs, crustaceans, and fishes (Herbert and Wakeford, 1964; Jones, 1975; Bryant, et al., 1985).

Table 5. Heavy metals in seawater and sediment "baseline" values from inner Pago Pago Harbor.

Detection Limits		Seawater[1] (ppm)	Seawater[2] (ppm)	Sediment (mg/Kg dry weight)[3]	
.001	Ag	<0.010	<0.010	1.7	(excl. Site 6)
.010	As	<0.010	<0.010	4.0	(excl. Site 6)
.001	Cd	<0.010	<0.010	1.2	(excl. Sites 5&6)
.005	Cr	0.03	<0.020	60	
.001	Cu	0.09	0.100	46	(excl. Sites 3&4)
.010	Pb	0.052	0.062[4]	54	(excl. Sites 3,4,&6)
.0002	Hg	<0.002	<0.010	0.06	(excl. Site 3)
.010	Ni	<0.25	<0.25	56	
.001	Zn	<0.05	0.105	400	(excl. Site 6)

1 Mean value for Sites 1 and 4; May 1990.
2 Mean value for Sites 1 and 4; October 1990. (1991?)
3 Mean of nonexcluded sites multiplied by 2 (see text page 12)
4 At Site 4 only; undetected (<0.050) at Site 1 in October.

III.A.2. **Heavy Metals in Sediments**

The results of metals testing of sediments from Pago Pago Harbor must be compared with soils metals typical for volcanic soils and with estuarine and coastal sediments from polluted and unpolluted areas to assess the significance of the results. A number of metals, while considered priority pollutants, occur naturally in the environment at relatively high concentrations. Basalts are a rich source of several heavy metals (Nakamura and Sherman, 1958). Usually, these mineralized metals occur in insoluble forms and are therefore not very mobile (that is, do not move readily into solution in the aquatic environment). Weathering of native rocks is the principal process whereby metals are released into streams and ponds, and thus these metals would be expected in sediments derived from erosion of terrigenous material as is shown in Table 6. For example, chromium appears to be naturally concentrated in weathered basalts, becoming less concentrated as the soil is eroded and carried as bedload in a stream and then added to coastal deposits. Lead, although leached out of the parent material, is complexed in the fine deposits of stream and particularly estuarine sediments, where its concentration rises.

The toxicity of these precipitated or adsorbed forms is not very great under circumstances normally encountered in aquatic environments because they remain bound to the sediment so long as the pH is neutral or slightly basic, becoming soluble only if the pH shifts to acidic. Nonetheless, sediments are a source of contaminants to the water column and the organisms which live within and on the bottom. Standards or classifications of sediment pollution levels have been proposed (see Table 7) but not formerly codified in the United States (Shea, 1988). Potential risks to the environment are usually assessed through biotoxicity studies (see Giesy and Hoke, 1990).

In a study of heavy metals in estuarine sediments in Hawaii (DOH, 1978), the Department of Health found a relative abundance of nickel, zinc, chromium, lead, and copper and concluded that "...[estuarine sediment] metal concentrations in general appear to be influenced by soil mineral composition and weathering of Hawaiian basalts ...." This source would be what Jonasson and Timperley (1975) term the "catchment regime".

With regard to the results presented in Table 6, it is to be noted that Kahana Bay, on the windward coast of Oahu, Hawaii, is a relatively pristine area with an undeveloped watershed. Ku Tree Reservoir represents an equally pristine watershed in the Ko'olau Range east of Wahiawa on Oahu. How-

Table 6. Heavy metals concentrations (ppm*) in basalts, soils, and stream bed and coastal sediments in Hawaii.

METAL	KOLOA BASALTS (1)	KOLOA SAPROLITE (1)	KU TREE SEDIMENTS (2)	KAHANA SEDIMENTS (3)	COASTAL SEDIMENTS (4)
As			2-17	3-12	ND-29
Cd			ND-2	ND-2	ND-10
Cr	400	560-860	209-403	47-147	1-122
Cu	290	33-80	47-160	ND-160	
Hg			0.3-0.5	ND-0.2	ND-2
Ni	840	250-580	108-350	ND-350	
Pb	12	0.5-3	21-34	5-34	5-58
Zn					ND-105

* - Table values are mg/Kg (ppm) of dried material.
(1) - Patterson, 1971; basalt and weathered basalt.
(2) - AECOS, 1984; Ku Tree Reservoir.
(3) - Lau, et al. , 1973; Kahana Stream sediments.
(4) - Lau, et al. , 1973; Kahana Bay sediments.

ever, activities (military training or dam construction) around the reservoir may have influenced sediment metals concentration values at the latter location. Nonetheless, the values in Table 6 are intended to be representative of the catchment and estuarine regimes in the absence of anthropogenic (pollution) influences. These values are in line with the natural contents of heavy metals in fine sediments from tropical rivers (Thailand and Java) reported in de Groot and Allersma (1975).

Although many of the heavy metals present in the soils and estuarine sediments of both Hawaii and Samoa can be attributed to the geochemistry of the catchment regime (i.e., it is volcanic), a comparison of values in Table 8 demonstrates that urban pollution ("contamination regime" of Jonasson and Timperley, 1975) is a significant contributor to some estuarine sediment concentrations in Hawaii. Locations which are clearly the more urban/industrial of those sampled in the DOH study are the Ala Wai Canal (Waikiki) and Kapalama Canal (Kalihi). For most of the metals measured these two locations show the highest levels reported (exceptions being cadmium and arsenic). The high arsenic value obtained at Hilo Bay is traceable to an industrial source.

Table 7. Toxicity classifications of sediments for various heavy metals (in ppm dry weight of material)(from Baudo and Muntau, 1990).

Element	Ontario (MOE)	EPA 1977 Non-polluted	EPA 1977 Moderately polluted	EPA 1977 Heavily polluted
As	8	< 3	3-8	> 8
Ba		< 20	20-60	> 60
Cd	1			> 6
Cu	25	< 25	25-50	> 50
Cr	25	< 25	25-75	> 75
Fe	10,000	< 17,000	17-25,000	> 25,000
Total Hg	0.3	< 0.1		> 0.1
Mn		< 300	300-500	> 500
Ni	25	< 20	20-50	> 50
Pb	50	< 90	90-200	> 200
Zn	100	< 90	90-200	> 200

Sources: Gambrell et al. (1983); Thomas (1987).

Table 8. Distribution of heavy metals in Hawaiian estuarine sediments (after DOH, 1978).

Location	Cu	Zn	Pb	Cd	Cr	Ni	Hg	As
	Metal (Mean* - ppm dry weight)							
Kaneohe Bay	73	121	80	2.5	184	161	0.29	20
West Loch	129	232	96	<10	198	308	0.60	4
Ala Wai Canal	195	386	535	3.5	230	197	1.40	14
Kapalama Canal	273	523	392	6.5	126	100	1.10	17
Kaiaka Bay	103	132	33	<10	200	249	0.36	12
Kahana Bay	22	44	96	11	20	81	<0.25	18
Nawiliwili Bay	78	83	56	22	347	249	<0.25	14
Hanapepe Bay	60	116	35	3.5	212	400	<0.25	19
Manele/Hulopoe	118	71	<100	<10	118	427	<0.25	<4
Hilo Bay	98	198	115	5.0	207	126	0.75	675

* Mean values rounded to simplify table
< = Values are minimum detectable limit for the samples analyzed.

Perhaps the most extensive study of heavy metals in marine sediments in Hawaii was that reported by the Naval Undersea Center (1974) for Pearl Harbor, citing and organizing the results of studies by the Naval Civil Engineering Laboratory (Morris and Youngberg, 1972; Youngberg, 1973). Sediment samples were collected from 95 locations in Pearl Harbor. Results for 92 stations are summarized in Table 9. This study also included samples of soils and stream sediments from the surrounding watershed. The NUC (1974) report presented data on copper, lead and zinc in two other harbors for comparison purposes (Table 10).

Table 9. Summary of results on sediment metals (mg/kg dry weight) measured at 92 stations in Pearl Harbor, Hawaii (NUC, 1974).

Metal	Mean	Std. Dev.	Metal	Mean	Std. Dev.
Ag[1]			Hg	1.10	1.29
Cd	0.88	±1.83	Mn	573	±577
Cr	101	±59	Ni	125	±148
Cu	156	±192	Pb	114	±213
Fe	33776	±20771	Zn	250	±293

[1] Fewer samples were analyzed for silver and thus no "grand" mean was provided. Highest concentrations were found in 39 samples from Southeast Loch (6.6 ±6.0 mg Ag/Kg)

Sediment samples were collected from six sites within Pago Pago Harbor on 19 April 1990. Site 6 had to be resampled because an insufficient quantity of material for all of the analyses to be performed. Resampling took place on 29 March 1990. The Site 1 sample was split and used by the laboratory for replicate and spiked sample analyses. The results of the tests for arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc on these sediments are given in Table 11 and Appendix A. With a few exceptions, the variation between sites is not great, permitting calculation of a "baseline" value. Unfortunately, the values are reported as concentrations in wet sediments which introduces an unknown variable. However, because only a few sites gave either unusually high or low values relative the majority of sites, and the deviations were limited to only a few of the nine metals measured, the conclusion seems warranted that the sediments were generally similar to one another with respect to water content.

Table 10. Comparison of copper, lead, and zinc content of sediments from three Navy harbors (after NUC, 1974).(values in mg/Kg dry wt;mean ± std. dev.(n))

	San Diego Bay California	Pearl Harbor (Southeast Loch)	Apra Harbor Guam
Fleet Active Areas			
Cu	290 ±370(9)	240 ±240(39)	240 ±280(3)
Pb	120 ±100(9)	210 ±300(39)	200 ±250(3)
Zn	430 ±310(9)	350 ±400(39)	400 ±400(3)
Fleet Inactive Areas	San Diego Bay California	Pearl Harbor (Middle Loch)	Apra Harbor Guam
Cu	220 ±80(8)	120 ±50(14)	35 ±12(2)
Pb	62 ±29(7)	32 ±27(14)	13 ±8(2)
Zn	370 ±170(8)	200 ±80(14)	54 ±30(2)

Sources:

Table 11. Heavy metals in April/May 1990 sediment samples from Pago Pago Harbor (mg/kg sediment wet weight).

	Site 1	Site 1 (dup)	Site 2	Site 3	Site 4	Site 5	Site 6
Ag	0.84	1.01	1.10	0.70	0.32	1.13	7.2
As	2.09	1.97	2.25	2.00	1.60	2.05	24.8
Cd	0.69	0.70	0.60	0.79	0.32	1.34	2.7
Cr	27.4	37.4	25.1	47.6	38.6	16.8	17.4
Cu	26.3	27.7	21.7	122.0	344.0	27.3	11.2
Hg	0.03	0.04	0.03	0.09	0.02	0.04	0.03
Ni	27.0	32.9	25.5	36.8	20.4	20.8	31.0
Pb	25.9	27.6	27.5	53.8	42.3	27.0	41.5
Zn	158.0	159.0	162.0	234.0	240.0	246.0	41.6

Another factor which may have a bearing on the interpretation of the harbor sediment results has to do with composition of the sediment. We expect that these sediments are a mixture of particles from the catchment basin (terrigenous, usually volcanic material), marine limestones, and biological (organic) sources. For those metals whose origin is the weathering of basalt and which are transported into the bay in insoluble form, the concentration in a given sample would be dependent upon the relative proportion of terrigenous material to material of other origins in the sediment. At one time, the basic surface sedimentary framework of Pago Pago Harbor was limestone, with areas near the mouths of streams having a higher proportion of terrigenous sediments. Production of limestone since removal of the fringing reefs from the inner harbor is probably no longer significant. Thus, recently deposited material on the harbor bottom is quite probably mostly of volcanic orgin.

The baseline sediment concentrations given in Table 5 are rounded means from all of the site values for each metal which did not deviate substantially from the median value (i.e., all of the values in Table 11 except those listed as "excluded" in Table 5). The baseline concentrations provide a "typical" concentration for inner Pago Pago Harbor sediment and are not intended to be mathematically rigorous derivations. These values have been adjusted for comparison with the sediment concentrations given in Tables 6 through 10 which are presented on a dry weight basis. Although water content can vary considerably in marine sediments, a reasonable estimate for inner Pago Pago Harbor sediment from Table 1 would be a water content of 55%. Thus the mean values calculated from Table 11 have been multiplied by factor of two for Table 5. Even using a multiplier of 3 (assuming 66% moisture content) places the baseline concentrations of metals in the Pago Pago sediments below most sediments from estuaries and embayments in Hawaii. Reference to Table 7 provides a method of classifying the Pago Pago Harbor sediments, although caution is warranted given that natural background concentrations in American Samoa soils of these heavy metals would probably exceed the pollution criteria presented.

Deviations from the baseline concentrations were noted for specific metals at the following Pago Pago Harbor locations:

Site 3 -- High copper, lead, and mercury;
Site 4 -- High copper and lead;
Site 5 -- High cadmium;
Site 6 -- High arsenic, cadmium, lead, and silver;
Site 6 -- Low zinc and perhaps copper.

The chromium concentrations at Sites 5 and 6 were low relative to the other sites, although the baseline value given in Table 5 for this element is based on a mean calculated from all seven analyses.

The sites can be roughly ranked by noting how many maximum values occured at each. By this accounting, Site 3 (followed by Site 6) appears "most polluted". Either Site 3 or Site 6 would appear to rank highest considering the list of deviations above. Site 3 is located off the village of Lalopua, west of the marine railway; Site 6 is located off Fagatogo, west of the commercial docks (Figure 1).

The low chromium values at Sites 5 and 6 and the low zinc and copper values at Site 6 may defy explanation without further study, but do raise at least one concern: could the low values reflect a dilution of the sediment/water ratio? That is, if either chromium, zinc, or copper in the harbor muds are not at all anthropogenic, but reflect only terrigenous influences (i.e., volcanic soil run-off), a low value in a sample could be the result of a higher proportion of either limestone or water. If water, then the concentrations of all the metals in that sample expressed on a dry weight basis would require a greater factor than the 2 applied here.

III.A.3. **Tissue Heavy Metals**

Sediment heavy metals may serve as a source of contamination to organisms which live in or on the sediments, and these organisms can in turn become a source of contamination to pelagic species. It has been suggested by Li (1984) that living organisms separate elements into biophile and biophobe categories. By normalizing concentrations over silicon, the biophile elements are those which appear enriched in living tissues compared with the sediment (tissue to sediment clay ratios of between 100 and 1000), while biophobe elements have tissue to sediment ratios close to 1. Heavy metals measured in the Pago Pago Harbor study which are thought to be biophilic, at least for algae (Li, 1984), are zinc, mercury, arsenic, cadmium, and silver. These may not be essential for life processes, but probably are involved in physiochemical processes. Biophobic elements include nickel and chromium. Lead and copper are intermediate (ratios between 1 and 100). The bioconcentration factor (BCF) is another way of assessing the relative risks associated with sediment or water concentrations of heavy metals relative to the resident biota. Table 12 lists the EPA priority-pollutant metals in descending order of bioaccumulation potential, according to their BCF (Tetra Tech, 1985).

The literature containing chemical analyses of plant and animal tissues from Hawaiian aquatic environments is sparse. The State of Hawaii, Department of Health measured heavy

Table 12. Inorganic priority pollutants ranked according to Bioconcentration Factor (USEPA, 1989).

Priority Pollutant No.	Substance	log BCF[1]
123	methylmercury	4.602
123	phenylmercury	4.602
123	mercuric acetate	3.447
120	copper	3.073
128	zinc	2.762
115	arsenic	2.544
118	cadmium	2.513
122	lead	2.253
119	chromium VI	2.190
119	chromium III	2.104
123	mercury	2.000
124	nickel	1.699
127	thallium	1.176
114	antimony	ND
117	beryllium	ND
121	cyanide	ND
125	selenium	ND
126	silver	ND

1 - BCF = Bioaccumulation Factor. The value shown is the geometric mean BCF among studies summarized by Tetra Tech (1985). See also USEPA (1986)
ND - No data

metals, chlorinated pesticides, and PCBs in Hawaiian estuaries and estuarine organisms, including mullet (<u>Mugil cephalus</u>), crabs (<u>Podophthalmus vigil</u>, <u>Portunus sanguinolentus</u>, <u>Thalamita crenata</u>, and others not identified), clams (<u>Tapes phillipinarium</u>), oysters (<u>Crassostrea virginica</u>), and opihi (<u>Cellana sandwicensis</u>) (DOH, 1978). The NOAA Mussel Watch program has included Hawaii sites in some years (see Freitas, et al., 1989). Species of oysters (mostly <u>Ostrea sandwicensis</u> and <u>O. hanleyana</u> are substituted for mussels and edible oysters (<u>Crassostrea virginica</u>) used on the west and east coasts of the continental United States in this program. The National Contaminant Biomonitoring Program (NCBP) maintained by the U.S. Fish and Wildlife Service has included two streams on Oahu in a nation-wide network of 101 sites from which fish tissues have been analyzed for heavy metals since 1976 (Schmitt and Brumbaugh, 1990).

Table 13. Concentrations of metals in six whole fish from Hawaiian freshwater streams (after Schmitt and Brumbaugh, 1990).

Species	metal (mg/Kg wet-wt.) As	Cd	Cu	Hg	Se	Pb	Zn	% water
<u>Poecilia vittata</u>	0.12	0.06	8.54	0.04	0.76	1.56	46.40	68.0
<u>Oreochromis mossambica</u>	0.14	0.06	23.1	0.03	0.92	1.98	28.47	71.1
<u>O. mossambica</u>	0.12	0.06	19.2	0.03	0.62	2.20	27.33	69.6
<u>Poecilia vittata</u>	0.34	0.03	5.56	0.03	4.88	0.28	29.61	71.8
<u>O. mossambica</u>	0.32	0.04	10.9	0.03	3.95	0.31	30.03	71.4
<u>Clarias fuscus</u>	0.06	0.02	3.38	0.08	1.30	0.29	48.66	68.4

The results of fish tissue analyses for heavy metals from the Pago Pago Harbor fish samples are presented in Tables 15A and 15B. The tissues display a wide range of concentrations for each of the elements tested. For most metals, the mean concentration in liver tissues is slightly to considerably greater than the mean concentration in flesh. Arsenic, mercury, and zinc are particularly concentrated in the liver (factors between 5 and 10), with copper and lead less so (factors of 3).

With very few exceptions, tissue concentrations are well below sediment concentrations for each metal. The significant exceptions involve mercury, with the tissue levels (mostly liver) consistently higher than the "baseline" sediment value (wet or dry basis). The mean mercury concentration in muscle tissue (all fishes) equals the "baseline" wet sediment concentration (0.03 mg/Kg) and the mean mercury concentration in liver tissue is some 4.5 times greater (0.14 mg/Kg). Indeed, the sediment results seem not to implicate mercury as a pollutant in Pago Pago harbor muds. Mercury does have a high bioaccumulation potential (see Table 12). Inorganic and organic mercury can be converted by microorganisms into methyl or dimethyl mercury (Jensen and Jernelov, 1969; Bisogni and Lawrence, 1973), providing a ready pathway between sediment mercury and biological systems.

Table 14 Compilation of legal limits for hazardous metals in fish and fishery products (from USEPA, 1989)

Country	As	Cd	Cr	Cu	Hg	Pb	Sb	Se	Zn
	Metals (ppm)								
Australia	1.0,1.5[b]	0.2-5.5		10-70	0.5,1.0	1.5-5.5	1.5	1.0,2.0	40-1,000
Brazil					0.5[c]				
Canada	3.5				0.5	0.5			
Chile	0.12,1.0	0.5		10		2.0		0.05,0.3	100
Denmark					0.5				
Ecuador	1.0			10	1.0	5.0			
Finland	5.0				1.0	2.0			
France					0.5,0.7				
Germany		0.5			1.0	0.5			
Greece					0.7				
Hong Kong	1.4-10	2.0	1.0		0.5	6.0	1.0		
India	1.0			10	0.5[c]	5.0			50
Israel					0.5				
Italy					0.7[f]	2.0			
Japan					0.3,0.4[c]				
Korea					0.5				
Netherlands		0.5-1.0			1.0[f]	0.5,2.0			
New Zealand	1.0	1.0		30	0.5[c]	2.0	1.0	2.0	40
Philippines	3.0				0.5	0.5			
Poland	4.0			10-30		1.0-2.0			30-50
Spain					0.5				
Sweden					1.0[f]	1.0-2.0			
Switzerland		0.1			0.5	1.0			
Thailand	2.0			20	0.5	1.0			
United Kingdom	1.0			20		2.0-10			50
United States					1.0[f]				
U.S.S.R.					0.2-1.0				
Venezuela	0.1	0,0.1		10	0.1-0.5	2.0			
Zambia	3.5-5.0			100	0.2-0.3	0.5-10			100
Range									
Minimum	0.1	0	1.0	10	0.1	0.5	1.0	0.05	30
Maximum	10	5.5	1.0	100	1.0	10	1.5	2.0	1,000

[a] Limit varies among states.
[b] Inorganic
[c] Total.

References: Nauan (1983); U.S. Food and Drug Administration (1982, 1984).

Significant differences between herbivores, detritivores, and carnivores are not apparent. However, the mean metals concentrations for mullet flesh are, for all elements except mercury, greater than the means from all fish combined. Mullet liver tissue means exceed the overall means only for copper and lead.

Table 15A. Concentrations of silver, arsenic, cadmium, and chromium in fish tissues from Pago Pago Harbor.

[Batch] Sample	(mg/Kg wet tissue weight) Ag	As	Cd	Cr
		muscle tissues		
[1] 1 Acanthuridae (4/20) <u>Acanthurus</u> <u>xanthopterus</u>	0.26	0.01	0.20	1.9
[1] lab duplicate sample	0.35	<0.01	0.20	1.2
[2] 2 Gerreidae (matu) <u>Gerres</u> sp. (4/20/90)	0.45	0.03	0.30	33.8
[2] 2 small Carangidae (lupo) <u>Urapsis</u> sp. (4/20/90)	0.15	<0.01	0.37	5.5
[4] 1 Lutjanidae (tamala) <u>Lutjanus</u> <u>fulvus</u> (4/24)	0.13	<0.01	0.33	4.6
[7] 2 Mugilidae mullet (4/30-5/6/90)	0.6	0.15	0.5	21.7
[11] Muglidae mullet (Oct 10-19,'90)	0.09	0.044	0.18	0.44
[12] Muglidae mullet (Oct 10-19,'90)	0.09	0.053	0.10	2.05
[13] Acanthuridae (Oct 1990) <u>Acanthurus</u> <u>xanthopterus</u>	0.05	0.026	0.10	0.48
[13] lab duplicate sample	0.02	0.021	0.09	0.31
Mean	**0.22**	**0.034**	**0.24**	**7.20**
Std. Dev.	0.18	0.042	0.13	10.75
		liver tissues		
[1] <u>Acanthurus</u> (4/20)	0.7	0.52	0.4	2.3
[5] Carangidae (4/30-5/6)	0.7	0.37	1.3	5.5
[7] Mugilidae (4/30-5/6)	0.7	0.79	0.4	19.1
[8] Gerreidae (4/30-5/6)	0.4	0.60	0.4	44.1
[9] <u>Acanthurus</u> (4/30-5/6)	0.4	0.27	0.3	11.7
[10] Mugilidae mullet (Oct 10-19,'90)	0.03	0.057	0.12	0.45
[12] Mugilidae mullet (Oct 10-19,'90)	0.12	0.122	0.10	0.60
[13] Acanthuridae (Oct 1990) <u>Acanthurus</u> <u>xanthopterus</u>	0.05	0.156	0.13	0.19
[13] lab duplicate sample	0.06	0.12	0.17	0.05
Mean	**0.35**	**0.334**	**0.37**	**9.33**
Std. Dev.	0.28	0.240	0.35	13.74

Table 15B. Concentrations of copper, mercury, nickel, lead, and zinc in fish tissues from Pago Pago Harbor

[Batch] Sample	Cu	Hg	Ni	Pb	Zn
	(mg/Kg wet tissue weight)				
muscle tissues					
[1] 1 Acanthuridae (4/20)					
Acanthurus sp.	0.61	0.06	1.3	1.1	9.3
[1] lab duplicate	0.44	0.04	1.9	0.9	8.5
[2] 2 Gerreidae					
Gerres sp. (4/20)	1.32	<0.01	11.8	1.6	16.5
[3] 2 small Carangidae					
Urapsis sp. (4/20)	0.29	0.05	3.1	1.9	23.0
[4] 1 snapper or tamala					
Lutjanus fulvus	0.46	0.08	4.1	2.5	12.2
[7] 2 Mugilidae					
(4/30-5/6/90)	1.6	0.02	8.1	2.6	18.6
[11] Muglidae					
mullet (10/10-19)	3.38	<0.01	1.2	0.7	13.4
[12] 3 Muglidae					
mullet (10/10-19)	9.83	<0.01	2.9	7.9	14.6
[13] 8 acanthurids					
A. xanthopterus	5.62	<0.01	<0.1	0.1	3.6
[13] lab duplicate	0.5	<0.1	0.1	3.6	2.9
Mean	**2.4**	**0.03** *	**3.8** *	**2.9**	**12.3**
Std. Dev.	3.0	0.03	3.4	2.1	6.0
liver tissues					
[1] Acanthuridae (4/20)					
A. xanthopterus	5.8	0.46	1.9	1.6	75.6
[5] Carangid	5.5	0.06	1.2	1.4	32.9
[7] Mugilidae (mullet)					
(4/30-5/6/90)	19.2	0.05	4.8	2.1	53.9
[8] Gerreidae (4/30-5/6)					
Gerres sp.	3.0	0.12	11.6	3.6	45.7
[9] Acanthurids (4/30-5/6)					
A xanthopterus	11.7	0.23	2.4	0.7	195.6
[10] Mugilidae					
mullet (Oct 10-19)	2.45	<0.01	0.4	0.3	9.3
[12] Mugilidae					
mullet (Oct 10-19)	2.61	<0.01	0.9	73.8	13.2
[13] Acanthurids (Oct 1990)					
A. xanthopterus	7.73	0.16	0.3	0.4	67.7
[13] lab duplicate	11.45	0.14	0.3	<0.1	109.1
Mean	**7.72**	**0.14** *	**2.6** *	**9.3**	**67.0**
Std. Dev.	5.23	0.13	3.4	22.8	54.2

no Std   no Std

* Human Health
WQ Criteria
Fish Consumption

III.B **Total Chlorinated Pesticides**

use method 608

Replaced w/#608

Too hi det. limit

Total chlorinated pesticide measurements by Method 211.100 (FDA-PAM, Vol. I) and EPA Method 8080 provides a scan of ~~some~~ 19 different pesticides and pesticide breakdown products. A list of the compounds included in this analysis is given below. Sediment samples collected in April/May 1990 from Pago Pago Harbor at the locations shown in Figure 1 were analyzed. The detection limits for the sediment samples ranged from 0.01 to 0.20 mg/Kg of sediment wet weight. None of the compounds listed in Table 16 were found in the sediments.

Table 16. List of chlorinated pesticides and derivatives tested for in sediment and tissue samples from Pago Pago Harbor.

Aldrin	Endosulfan I
a - BHC	Endosulfan II
b - BHC	Endosulfan sulfate
c - BHC	Endrin
d - BHC	Endrin aldehyde
Chlordane	Heptachlor
4,4'-DDD	Heptachlor epoxide
4,4'-DDE	Toxaphene
4,4'-DDT	Methoxychlor
Dieldrin	

Fish tissue samples were subjected to analysis for the same list of pesticides (Table 16) with achieved detection limits ranging between 0.005 and 0.5 mg/Kg of tissue wet weight (see Appendix B). No detectable concentrations of these compounds were found in any of the tissue samples with the following exception: both p,p'-DDE and p,p'-DDD were found in a sample (and a duplicate of that sample) of muscle tissue from mullet ('anae) caught in the harbor. Averaged concentrations were 0.038 ppm p,p'-DDE and 0.016 ppm p,p'-DDD.

The compounds detected are metabolites of the chlorinated insecticide, DDT (Menzie, 1978), although p,p'-DDD was at one time also marketed as an insecticide (as TDE or "Rhothane"). Toxicity to mammals is about one-fifth that of DDT (McKee and Wolf, 1963). DDT and its breakdown products readily partition into animal fats where they tend to accumulate. Because of the persistence of DDT and its toxic metabolites, and the potential for bioaccumulation into higher animals including man, these compounds have been replaced by less persistent chemicals for most uses (McKee and Wolf, 1963; BCPC, 1991).

Within the United States, total DDT in fresh water fish tissue samples was found to be ubiquitous. Discussing the 1984 results of a nationwide study of fresh water fishes, Schmitt et al (1990) noted that residues derived from DDT were present in 98% of the stations (including Hawaii). This result represented the first time since the beginning of their study in 1974 that DDT (as p,p'-DDE) was not detected in fish tissues from all of the sample stations.

The proportional composition of the DDT mixture in fresh water fish tissue was found to be typically 70% p,p'-DDE, 20% p,p'-DDD, and 10% p,p'-DDT between 1976 and 1981. The DDE proportion increased to 73% in 1984, indicating continued weathering of DDT in the environment generally in North America. The 1981 Hawaii samples from Waikele Stream contained the highest proportion of p,p'-DDT (54-61% of total DDT) in the nationwide study, but p,p'-DDT had declined by 1984 (Schmitt, et al., 1990). Total DDT in three fish tissue samples from Manoa Stream on Oahu in 1984 averaged 0.55 mg/Kg (ppm). In these samples, p,p'-DDT was 20% of total DDT. The absence of p,p'-DDT (tissue detection limit = 0.005 mg/Kg) in the sample from Pago Pago Harbor suggests that the source of the pesticide is NOT from a recent use of DDT, but represents weathered product in the environment.

The DDT group (DDT and its isomers) have been measured in marine bivalves nationwide by the National Status and Trends Mussel Watch Program (Freitas, et al., 1989). During Phase 3 of this program, isomers of DDT accounted for 60% of the chlorinated pesticide residues found, and 80% of total pesticides in areas with high pesticide loads. Tissue concentrations for total DDT in the oyster, Ostrea sp., from Hawaii were under 0.050 mg/Kg dry weight.

III.C Polychlorinated Biphenyls

Polychlorinated biphenyls or PCB's are synthetic chlorinated compounds produced under the trade name Aroclor (Monsanto) and once widely used in a variety of products and processes. After the early 1970's, PCB's were produced exclusively for use as dielectric fluids in electrical capacitors, switches, and transformers. Polychlorinated biphenyls are remarkably stable and persistent once released into the environment (Peakall and Lincer, 1970); and share lipophilic characteristics with compounds such as DDT that result in biological accumulation and food chain magnification. Polychlorinated biphenyls have relatively high octanol-water coefficients which are a relative measure of bioaccumulation potential (TetraTech, 1985). Marine and estuarine organisms pick up PCB's from both the sediment and the water, and these can accumulate to high levels in organisms at the top of the food chain (Lincer, 1975).

Sea water samples from Site 1 and Site 4 were analyzed for seven different Aroclors with the results as shown in Table 17. None of the seven common aroclor mixtures were detected in the water samples collected in March or October. Similar results for sea water off Kakaako (Honolulu), Hawaii were reported by AECOS (1990).

Table 17. Results of analyses for polychlorinated biphenyls (PCB's) in sea water samples from inner Pago Pago Harbor (table values are lower detection limits in ug/L or ppb).

	March 1990		October 1990	
	Site 1	Site 4	Site 1	Site 4
Aroclor				
1016	< 6	< 6	< 1	< 1
1221 det. limit	< 6	< 6	< 5	< 5
1232	< 6	< 6	< 2	< 2
1242 0.065	< 3	< 3	< 1	< 1
1248	< 6	< 6	< 1	< 1
1254	< 1	< 1	< 1	< 1
1260	< 1	< 1	< 1	< 1

Results of the analysis for PCB's on sediment samples collected from Pago Pago Harbor in April and May 1990 are shown in Table 18. Only Aroclor 1260 was detected in the inner harbor muds, but this PCB was present at all sites except Site 6. Levels of Aroclor 1260 at Sites 1 and 2 (off Pago Pago) are close to the the lower limit of detection (which is 0.10 ppm for this aroclor). Levels in the sediments from Sites 3, 4, and 5 are 15 to 20 times as great. These three locations extend along the north side of the inner harbor. Thus, the results suggest a pattern of distribution in the sediment pointing to a single source of Aroclor 1260; i.e., possibly a single, specific incident of dumping or accidental spillage. Collection and analysis of additional samples in a grid pattern could better define the source and the extent of contamination.

Table 18. Polychlorinated biphenyls (PCB's) in Pago Pago Harbor sediment samples (mg/Kg sediment wet weight).

	Site						
	1	1	2	3	4	5	6
Aroclor		dup					
1016	ND	ND	ND	ND	ND	ND	ND
1221	ND	ND	ND	ND	ND	ND	ND
1232	ND	ND	ND	ND	ND	ND	ND
1242	ND	ND	ND	ND	ND	ND	ND
1248	ND	ND	ND	ND	ND	ND	ND
1254	ND	ND	ND	ND	ND	ND	ND
1260	0.13	0.19	0.22	1.9	2.0	1.5	ND

ND - not detected at lower limit of detection which varies between 0.1 and 0.2 ppm for each aroclor (see Appendix).

PCBs have been measured in fresh water fish in Hawaii (Schmitt, et al., 1983, 1990) as part of a national program that included fish sampled from Waikele and Manoa Streams on the Island of Oahu. Compared with national averages, samples from Hawaii ranked quite high for DDT, dieldrin, chlordane, and heptachlor; and "significant Arochlor 1248 residues (> 1.0 ug/g wet weight) were found..." in one fish from Manoa Stream. Concentrations of Aroclor 1260, regarded as more persistent in the environment than Aroclor 1248, ranged from ND to 0.2 in tilapia and 0.3 to 0.5 in Cuban limia (Poecilia vittata) from Manoa Stream. Fish samples collected in 1984 (Schmitt, et al., 1990) produced lower levels of PCBs (Aroclor 1248 ranged from ND to 0.1 ppm; Aroclor 1254 from ND to 0.2 ppm; Aroclor 1260 from ND to 0.1 ppm). The downward trend comparing 1976 with later collections was generally apparent nation-wide. Similar levels (on the order of 0.25 ppm dry weight) of PCB have been reported for bivalves (Ostrea spp.) from both Honolulu Harbor and Nawiliwili Harbor (Freitas, et al., 1989). Samples of flesh tissue from several species of fish and a sea urchin from the waters off Kakaako (Honolulu) were tested by AECOS (1990). PCBs were detected in only one sample, that of an aholehole (Kuhlia sandvicensis) with 0.260 ppm Aroclor 1260.

Results of PCB testing of fish tissues from the catches made for the present study are given in Table 19. Results are given for "batch" numbers identified in the Methods section and in Table 15A and 15B. Lower limits of detection in these samples of fish muscle and liver tissues ranged from 0.05 to

Table 19. Polychorinated biphenyls (PCBs) in fish muscle and liver tissues from Pago Pago Harbor (mg/Kg wet tissue weight).

Fish Sample[1]	Aroclor 1060	1221	1232	1242	1248	1254	1260
				muscle tissue			
[1]	ND	ND	ND	ND	ND	ND	ND
[1] dup	ND	ND	ND	ND	ND	ND	ND
[2]	ND	ND	ND	ND	ND	ND	ND
[3]	ND	ND	ND	ND	ND	ND	ND
[4]	ND	ND	ND	ND	ND	ND	ND
[6]	ND	ND	ND	ND	ND	ND	ND
[10]	ND	ND	ND	ND	ND	ND	ND
[10] dup	ND	ND	ND	ND	ND	ND	ND
[12]	ND	ND	ND	ND	ND	ND	ND
[13]	ND	ND	ND	ND	ND	ND	ND
[14]	ND	ND	ND	ND	ND	ND	ND
[14] dup	ND	ND	ND	ND	ND	ND	ND
[15]	ND	ND	ND	ND	ND	ND	ND
[16]	ND	ND	ND	ND	ND	ND	ND
			liver tissue				
[5]	ND	ND	ND	ND	ND	ND	ND
[6]	ND	ND	ND	ND	ND	ND	ND
[7]	ND	ND	ND	ND	ND	ND	ND
[7] dup	ND	ND	ND	ND	ND	ND	ND
[8]	ND	ND	ND	ND	ND	ND	ND
[9]	ND	ND	ND	ND	ND	ND	ND
[14]	ND	ND	ND	ND	ND	ND	ND
[14] dup	ND	ND	ND	ND	ND	ND	ND
[15]	ND	ND	ND	ND	ND	ND	0.44
[16]	ND	ND	ND	ND	ND	ND	0.39

[1] numbers in brackets in left column reference batch numbers identified in Table 2

0.40 ppm of wet tissue wet for the seven aroclors analyzed. Only two fish samples showed detectable levels of PCB and only for aroclor 1260 (the same PCB congener found in Pago Pago Harbor sediment samples). Aroclor 1260 was found in liver tissue collected in January 1991 from both lai or jack (Scomberoides lysan) and from ga or mackerel (Rastrelliger kanagurta) at around 0.4 ppm. These are predatory species which range freely around the harbor and would qualify as species near the top of the food chain. PCBs were not detected in the flesh of these fish.

Limits for PCB's in fish and fishery products have been established by Canada, Netherlands, Sweden, Switzerland, and the United States (Nauen, 1983; USFDA, 1984). These vary from 1.0 to 5.0 ppm. The U.S. limit is 2.0 ppm (USFDA, 1984). Frietas et al. give the FDA action level as 10 ppm dry weight. Conversion of wet weight to dry weight concentration can be estimated for fish tissue by dividing by 0.2 (Hayes and Philips, 1987; AECOS, 1990), giving an approximate concentration of 2 ppm of dry tissue weight for the two Samoa fishes.

CONCLUSIONS

This assessment of chemical contamination in Pago Pago Harbor through testing of water, sediment, and fish tissue samples was preliminary in scope. No previous indications of specific problems existed prior to the efforts reported herein. Consequently, the results should be interpreted with caution. In cases where potential toxicants were found in detectable concentrations, comparable samples from other locations in American Samoa are not available to establish baseline levels or to determine if the problem is widespread in dimension.

Heavy Metals

The results of heavy metals testing are supplemented in this report with data from a variety of sources and criteria from EPA, State of Hawaii, Department of Health, and others to provide a basis for interpreting the significance of the Pago Pago Harbor results.

The seawater concentrations for most of the metals were below detection limits. In some cases, detection limits were above EPA and Hawaii salt water acute (nickel and silver) and/or chronic (cadmium, mercury, nickel, and silver) criteria. These criteria have been developed from laboratory bioassays, and may be set at concentrations lower than practical analytical methods can detect. The criteria are intended for application to point source discharges where measurements can be made made prior to discharge and initial dilutions of an effluent. Further measurements of these metals should follow only if specific problems are noted in sediment or tissue samples.

Only copper and zinc exceeded criteria values The acute and chronic criterion for copper in sea water is 0.0029 ppm (EPA, 1986); no criterion has been established by the State of Hawaii for copper in sea water. Because only four samples (collected on two occasions) were analyzed, it is difficult to conclude that specific problems exist with copper and zinc in the water column in inner Pago Pago Harbor.

Comparison of sediment metals concentrations from Pago Pago Harbor with toxicity classifications from EPA (1977) suggests that the harbor sediments are moderately to heavily polluted with arsenic, chromium, copper, nickel, and zinc. However, sediment values from Hawaiian marine and estuarine environments show similar "high" levels of arsenic, chromium, copper, nickel, mercury, and zinc in areas where pollution influences are thought to be slight or not present. Presumably, these metals are naturally present in the soils which wash into the estuaries and bays from volcanic formations. In Guam (Apra Harbor, fleet inactive portion), only copper exceeded the EPA informal sediment criterion (much of Guam is raised limestone).

A comparison of the "baseline" (Table 5) sediment values with Hawaii sediment values suggests a problem may exist with respect to zinc in Pago Pago Harbor. As noted above, concentrations of zinc in harbor water also appeared to be exceptional. Unusually high concentrations of some metals at specific sites within the Pago Pago Harbor may indicate localized problems which are more difficult to assess because of the limited number of samples (sediments were sampled only once). Metals values which appear high relative to experiences from Hawaiian locations include: copper, zinc, and possibly lead at Site 3; copper, zinc, and possibly lead at Site 4; and silver, arsenic, and possibly lead at Site 6. Zinc was high at all locations except Site 6.

Placing the fish tissue concentrations in perspective relative to regulatory standards such as those listed in Table 13 is difficult because of the range of limits established throughout the political world and the paucity of applicable standards in the United States. Using limit values which are widely established (rather than the maximum or minimum values), the Pago Pago Harbor fishes would seem to potentially have problems with chromium, copper, mercury, lead, and zinc burdens. If whole, cleaned fish or edible flesh tissue levels alone are considered, the list of metals of primary concern could be reduced to chromium and lead. However, no limits are expressed for either silver or nickel. Risk assessment analysis (USEPA, 1989) could be applied in this case, but is beyond the scope of the present report.

Pesticides Where are results?

Nineteen different chlorinated pesticides were analyzed for in sea water, sediment, and fish tissues from a variety of species caught in Pago Pago Harbor. No detectable concentrations were found in any of the water or sediment samples. In one tissue sample (and in a duplicate of that sample) from mullet, the DDT degradation products, p,p-DDE and p,p-DDD, were found at the tens of micrograms per kilogram (wet weight) levels. Although DDD may be found as the pesticide TDE (sold under the name "Rhothane"), the usualy source of DDD and DDE in the environment is weathering of DDT, a pesticide once widely used in the tropics for mosquito control. The concentration found is moderately high, on the order of 100 to

200 micrograms total DDT per kilogram of tissue dry weight. However, because only a single sample contained a detectable level of DDT metabolites, assessment of the significance of this finding would be highly speculative.

Polychlorinated Biphenyls (PCBs)

Seven different Aroclors (polychlorinated biphenyls) were analyzed for in sea water, sediment, and fish tissues from a variety of species caught in Pago Pago Harbor. Only Aroclor 1260 was detected in any of the samples. This Aroclor was fairly ubiquitous in inner Harbor muds, but clearly concentrated along the north side of the area sampled. Further testing of sediments in this area is recommended in order to pinpoint the extent and possibly the source of PCB contamination. Tissue analyses produced the interesting result of detectable concentrations in liver tissue only from top carnivores (and only Aroclor 1260). This result implies that Aroclor 1260 is present in the food chain at concentrations less than 0.1 ppm. Presumably this concentration could pose some risk to humans regularly eating fish and invertebrates taken from the Harbor. However, a risk assessment is beyond the scope of this report. Additional samples of top carnivores, particularly samples of fishes from other parts of American Samoa, should be analyzed to determine whether inner Pago Pago Harbor uniquely has a problem with PCB contamination.

Polynuclear Aromatic Hydrocarbons (PAH)

Sixteen different PAHs (polynuclear aromatic hydrocarbons) were analyzed for in sea water, sediment, and fish tissues from a variety of species caught in Pago Pago Harbor. No detectable concentrations were found in any of the sediment samples.

Volatile Organics

A total of 34 volatile organics were analyzed for in sea water and sediment samples from inner Pago Pago Harbor. None of these compounds were found at detection limits which varied from 0.005 to 0.02 ppm.

Oil and Grease / Total Petroleum Hydrocarbons

Oil and grease was measured in sediment samples from inner Pago Pago Harbor. Concentrations ranged from 300 to

7,000 ppm (sediment wet weight). Sea water samples were analyzed for total petroleum hydrocarbons (TPH) on two occasions. Only one sample contained a quantifiable amount: Site 4 at 0.25 ppm. No conclusion can be drawn from these results.

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APPENDIX A HEAVY METALS

Table A1. Heavy metals
Pago Pago Harbor sea water
Units = mg/L

Location:	Site 1	Site 4	Site 1	Site 1	Site 4
Date:	3/90	3/90	10/90	10/90	10/90
Silver (Ag)	<0.010	<0.010	<0.010	<0.010[1]	<0.010
Arsenic (As)	<0.010	<0.010	<0.010	<0.010[2]	<0.010
Cadmium (Cd)	<0.010	<0.010	<0.040	<0.040[3]	<0.040
Chromium (Cr)	0.033	0.030	<0.020	<0.020[4]	<0.020
Copper (Cu)	0.08	0.09	0.100	0.100[5]	0.100
Lead (Pb)	0.059	0.044	<0.050	<0.050[6]	0.062
Mercury (Hg)	<0.002	<0.002	<0.010	<0.010[7]	<0.010
Nickel (Ni)	<0.25	<0.25	<0.250	<0.250[8]	<0.250
Zinc (Zn)	<0.05	<0.05	0.100	0.100[9]	0.110

Spiked sample recoveries:
1 - 94% 2 - 100% 3 - 80% 4 - 100% 5 - 106%
6 - 86% 7 - 119% 8 - 115% 9 - 88%

Table A2. Heavy metals
Pago Pago Harbor sediment (April/May 1990) samples
Units = mg/kg sediment wet weight.

	Site 1	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Spike[1]
Ag	0.84	1.01	1.10	0.70	0.32	1.13	7.2	121%
As	2.09	1.97	2.25	2.00	1.60	2.05	24.8	95%
Cd	0.69	0.70	0.60	0.79	0.32	1.34	2.7	98%
Cr	27.4	37.4	25.1	47.6	38.6	16.8	17.4	52%
Cu	26.3	27.7	21.7	122.0	344.0	27.3	11.2	100%
Hg	0.03	0.04	0.03	0.09	0.02	0.04	0.03	93%
Ni	27.0	32.9	25.5	36.8	20.4	20.8	31.0	88%
Pb	25.9	27.6	27.5	53.8	42.3	27.0	41.5	100%
Zn	158.0	159.0	162.0	234.0	240.0	246.0	41.6	106%

1 - Spiked sample, percent recovery.

Table A3. Heavy Metals
Pago Pago Harbor fish muscle tissues
Units = mg/Kg tissue wet weight.

Batch:	[1]	[1]	[2]	[3]	[4]	[7]
Date:	4/90	4/90	4/90	4/90	4/90	5/90
Metal						
Arsenic	0.01	<0.01	0.03	<0.01	<0.01	0.15
Cadmium	0.20	0.20	0.30	0.37	0.33	0.50
Chromium	1.9	1.2	33.8	5.5	4.6	21.7
Copper	0.61	0.44	1.32	0.29	0.46	1.6
Lead	1.1	0.9	1.6	1.9	2.5	2.6
Mercury	0.06	0.04	<0.01	0.05	0.08	0.02
Nickel	1.3	1.9	11.8	3.1	4.1	8.1
Silver	0.26	0.35	0.45	0.15	0.13	0.6
Zinc	9.3	8.5	16.5	23.0	12.2	18.6

Table A3. Heavy Metals (continues)
Pago Pago Harbor fish muscle tissues
Units = mg/Kg tissue wet weight.

Batch:	[11]	[12]	[13]	[13]	Spike[1]
Date:	10/90	10/90	10/90	10/90	
Metal					
Arsenic	0.044	0.053	0.026	0.021	61%
Cadmium	0.18	0.10	0.10	0.09	88%
Chromium	0.44	2.05	0.48	0.31	91%
Copper	3.38	9.83	5.62	0.50	86%
Lead	0.7	7.9	0.1	3.6	86%
Mercury	<0.01	<0.01	<0.01	<0.01	46%
Nickel	1.2	2.9	<0.1	0.1	92%
Silver	0.09	0.09	0.05	0.02	84%
Zinc	13.4	14.6	3.6	2.9	94%

Table A4. Heavy Metals
Pago Pago Harbor fish liver tissues
Units = mg/Kg tissue wet weight.

Batch:	[1]	[5]	[7]	[8]	[9]	[10]
Date:	4/90	5/90	5/90	5/90	5/90	10/90
Metal						
Arsenic	0.52	0.37	0.79	0.60	0.27	0.057
Cadmium	0.4	1.3	0.4	0.4	0.3	0.12
Chromium	2.3	5.5	19.1	44.1	11.7	0.45
Copper	5.8	5.5	19.2	3.0	11.7	2.45
Lead	1.6	1.4	2.1	3.6	0.7	0.3
Mercury	0.46	0.06	0.05	0.12	0.23	<0.01
Nickel	1.9	1.2	4.8	11.6	2.4	0.4
Silver	0.7	0.7	0.7	0.4	0.4	0.03
Zinc	75.6	32.9	53.9	45.7	195.6	9.3

Table A4. Heavy Metals (continues)
Pago Pago Harbor fish muscle tissues
Units = mg/Kg tissue wet weight.

Batch:	[12]	[13]	[13]	Spike[1]
Date:	10/90	10/90	10/90	
Metal				
Arsenic	0.122	0.156	0.12	71%
Cadmium	0.10	0.13	0.17	86%
Chromium	0.60	0.19	0.05	82%
Copper	2.61	7.73	11.45	64%
Lead	73.8	0.4	<0.1	184%
Mercury	<0.01	0.16	0.14	126%
Nickel	0.9	0.3	0.3	89%
Silver	0.12	0.05	0.06	87%
Zinc	13.2	67.7	109.1	--

APPENDIX B CHLORINATED PESTICIDES

Table B1. Total chlorinated pesticides
Pago Pago Harbor sediments
Units = mg/kg (wet weight).

method 608 (ug/L)		Site 1	Site 1	Site 2	Site 3	Site 4
0.004	Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01
0.003	a-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
0.006	b-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
0.004	c-BHC (Lindane)	<0.01	<0.01	<0.01	<0.01	<0.01
0.009	d-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
0.014	Chlordane	<0.05	<0.05	<0.05	<0.05	<0.05
0.011	4,4'-DDD	<0.02	<0.02	<0.02	<0.02	<0.02
0.004	4,4'-DDE	<0.02	<0.02	<0.02	<0.02	<0.02
0.012	4,4'-DDT	<0.02	<0.02	<0.02	<0.02	<0.02
0.002	Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.05
0.014	Endosulfan I	<0.01	<0.01	<0.01	<0.01	<0.01
0.004	Endosulfan II	<0.01	<0.01	<0.01	<0.01	<0.01
0.066	Endosulfan Sulfate	<0.02	<0.02	<0.02	<0.02	<0.01
0.006	Endrin	<0.02	<0.02	<0.02	<0.05	<0.05
0.023	Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
0.003	Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01
0.083	Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01
	Methoxychlor	<0.03	<0.03	<0.03	<0.15	<0.15
0.24	Toxaphene	<0.20	<0.20	<0.20	<0.25	<0.25

APPENDIX B CHLORINATED PESTICIDES

Table B1. Total chlorinated pesticides (continued)
Pago Pago Harbor sediments
Units = mg/kg (wet weight).

	Site 5	Site 6
Aldrin	<0.01	<0.01
a-BHC	<0.01	<0.01
b-BHC	<0.01	<0.01
c-BHC (Lindane)	<0.01	<0.01
d-BHC	<0.01	<0.01
Chlordane	<0.05	<0.05
4,4'-DDD	<0.02	<0.02
4,4'-DDE	<0.02	<0.02
4,4'-DDT	<0.02	<0.02
Dieldrin	<0.01	<0.01
Endosulfan I	<0.01	<0.01
Endosulfan II	<0.01	<0.01
Endosulfan Sulfate	<0.01	<0.02
Endrin	<0.02	<0.01
Endrin Aldehyde	<0.01	<0.01
Heptachlor	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01
Methoxychlor	<0.15	<0.02
Toxaphene	<0.20	<0.20

Table B2. Total chlorinated pesticides
Pago Pago Harbor fish muscle tissue
Units = mg/kg tissue wet weight.

Batch:	[1]	[1]	[2]	[3]	[4]
Date:	4/90	DUP	4/90	4/90	4/90
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01
a-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
b-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
c-BHC (Lindane)	<0.01	<0.01	<0.01	<0.01	<0.01
d-BHC	<0.01	<0.01	<0.01	<0.01	<0.01
Chlordane	<0.06	<0.06	<0.06	<0.06	<0.06
4,4'-DDD	<0.01	<0.01	<0.01	<0.01	<0.01
4,4'-DDE	<0.02	<0.02	<0.01	<0.02	<0.01
4,4'-DDT	<0.02	<0.02	<0.01	<0.02	<0.02
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan I	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan II	<0.02	<0.02	<0.01	<0.01	<0.01
Endosulfan Sulfate	<0.02	<0.02	<0.02	<0.02	<0.02
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01
Methoxychlor	<0.02	<0.02	<0.02	<0.02	<0.02
Toxaphene	<0.15	<0.15	<0.15	<0.15	<0.15

Table B2. Total chlorinated pesticides (continued)
Pago Pago Harbor fish muscle tissue
Units = mg/kg tissue wet weight.

Batch:	[7]	[10]	[10]	[12]	[13]
Date:	4/90	10/90	DUP	10/90	10/90
Aldrin	<0.01	<0.005	<0.005	<0.005	<0.005
a-BHC	<0.01	<0.005	<0.005	<0.005	<0.005
b-BHC	<0.02	<0.05	<0.05	<0.05	<0.05
c-BHC (Lindane)	<0.01	<0.005	<0.005	<0.005	<0.005
d-BHC	<0.01	<0.005	<0.005	<0.005	<0.005
Chlordane	<0.07	<0.05	<0.05	<0.05	<0.05
4,4'-DDD	<0.02	**0.036**	**0.040**	<0.005	<0.005
4,4'-DDE	<0.02	**0.015**	**0.016**	<0.005	<0.005
4,4'-DDT	<0.03	<0.005	<0.005	<0.005	<0.005
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan I	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan II	<0.02	<0.01	<0.01	<0.01	<0.01
Endosulfan Sulfate	<0.03	<0.5	<0.5	<0.5	<0.5
Endrin	<0.02	<0.015	<0.015	<0.015	<0.015
Endrin Aldehyde	<0.02	<0.05	<0.05	<0.05	<0.05
Heptachlor	<0.01	<0.005	<0.005	<0.005	<0.005
Heptachlor Epoxide	<0.01	<0.005	<0.005	<0.005	<0.005
Methoxychlor	<0.03	<0.05	<0.05	<0.05	<0.05
Toxaphene	<0.16	<0.5	<0.5	<0.5	<0.5

Table B2. Total chlorinated pesticides (continued)
Pago Pago Harbor fish muscle tissue
Units = mg/kg tissue wet weight.

Batch: Date:	[14] 1/91	[14] DUP	[15] 1/91	[16] 1/91	[14] Spike[1]
Aldrin	<0.03	<0.03	<0.03	<0.03	94%
a-BHC	<0.015	<0.015	<0.015	<0.015	
b-BHC	<0.065	<0.065	<0.065	<0.065	
c-BHC (Lindane)	<0.015	<0.015	<0.015	<0.015	95%
d-BHC	<0.03	<0.03	<0.03	<0.03	
Chlordane	<0.3	<0.3	<0.3	<0.3	
4,4'-DDD	<0.03	<0.03	<0.03	<0.03	
4,4'-DDE	<0.03	<0.03	<0.03	<0.03	
4,4'-DDT	<0.03	<0.03	<0.03	<0.03	90%
Dieldrin	<0.03	<0.03	<0.03	<0.03	84%
Endosulfan I	<0.03	<0.03	<0.03	<0.03	
Endosulfan II	<0.03	<0.03	<0.03	<0.03	
Endosulfan Sulfate	<0.065	<0.065	<0.065	<0.065	
Endrin	<0.03	<0.03	<0.03	<0.03	87%
Endrin Aldehyde	<0.065	<0.065	<0.065	<0.065	
Heptachlor	<0.03	<0.03	<0.03	<0.03	
Heptachlor Epoxide	<0.03	<0.03	<0.03	<0.03	
Methoxychlor	<0.1	<0.1	<0.1	<0.1	
Toxaphene	<0.10	<0.10	<0.10	<0.10	

1 - Recovery (in per cent) of spike of sample from batch 14.

Table B3. Total chlorinated pesticides
Pago Pago Harbor fish liver tissue
Units = mg/kg tissue wet weight.

Batch:	[5]	[6]	[7]	[7]	[8]
Date:	5/90	5/90	5/90	DUP	5/90
Aldrin	<0.02	<0.04	<0.03	<0.03	<0.03
a-BHC	<0.04	<0.07	<0.05	<0.05	<0.05
b-BHC	<0.02	<0.04	<0.03	<0.02	<0.03
c-BHC (Lindane)	<0.02	<0.04	<0.03	<0.02	<0.03
d-BHC	<0.02	<0.07	<0.03	<0.02	<0.03
Chlordane	<0.10	<0.19	<0.14	<0.12	<0.14
4,4'-DDD	<0.04	<0.04	<0.05	<0.05	<0.05
4,4'-DDE	<0.04	<0.04	<0.05	<0.05	<0.05
4,4'-DDT	<0.04	<0.04	<0.05	<0.05	<0.05
Dieldrin	<0.04	<0.04	<0.05	<0.05	<0.05
Endosulfan I	<0.04	<0.04	<0.05	<0.05	<0.05
Endosulfan II	<0.04	<0.04	<0.05	<0.05	<0.05
Endosulfan Sulfate	<0.04	<0.04	<0.05	<0.05	<0.05
Endrin	<0.04	<0.04	<0.05	<0.05	<0.05
Endrin Aldehyde	<0.04	<0.07	<0.05	<0.05	<0.05
Heptachlor	<0.02	<0.04	<0.03	<0.03	<0.03
Heptachlor Epoxide	<0.02	<0.04	<0.03	<0.03	<0.03
Methoxychlor	<0.03	<0.06	<0.04	<0.04	<0.04
Toxaphene	<0.55	<1.0	<0.75	<0.65	<0.75

APPENDIX C POLYCHLORINATED BIPHENYLS (PCB)

Table C1. Polychlorinated biphenyls (PCB's)
Pago Pago Harbor seawater
Units = ug/L.

Location:	Site 1	Site 1	Site 4	Site 1	Site 1	Site 4
Date:	3/90	3/90	3/90	10/90	10/90	10/90
Aroclor						
1016	< 6	< 6	< 6	< 1	< 1	< 1
1221	< 6	< 6	< 6	< 5	< 5	< 5
1232	< 6	< 6	< 6	< 2	< 2	< 2
1242	< 3	< 3	< 3	< 1	< 1	< 1
1248	< 6	< 6	< 6	< 1	< 1	< 1
1254	< 1	< 1	< 1[1]	< 1	< 1	< 1
1260	< 1	< 1	< 1	< 1	< 1[2]	< 1

[1] - spiked sample recovery = 92%
[2] - spiked sample recovery = 85%

Table C2. Polychlorinated biphenyls (PCB's)
Pago Pago Harbor sediments
Units = mg/Kg sediment wet weight.

	Site						
Location:	1	1	2	3	4	5	6
Date:							
Aroclor							
1016	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
1221	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1232	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1242	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1248	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1254	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1260	0.13	0.19	0.22	1.9	2.0	1.5	<0.10

APPENDIX C POLYCHLORINATED BIPHENYLS (PCB)

Table C3. Polychlorinated biphenyls (PCB's)
Pago Pago Harbor fish muscle tissues
Units = mg/Kg tissue wet weight.

Batch:	[1]	[1]	[2]	[3]	[4]	[7]	[10]
Date:	4/90	DUP	4/90	4/90	4/90	5/90	10/90
Aroclor							
1016	<0.20	<0.20	<0.20	<0.20	<0.25	<0.20	<0.15
1221	<0.25	<0.25	<0.25	<0.25	<0.30	<0.25	<0.40
1232	<0.25	<0.25	<0.25	<0.25	<0.30	<0.25	<0.30
1242	<0.15	<0.15	<0.15	<0.15	<0.20	<0.15	<0.25
1248	<0.25	<0.25	<0.25	<0.25	<0.30	<0.25	<0.10
1254	<0.10	<0.10	<0.10	<0.10	<0.15	<0.10	<0.05
1260	<0.10	<0.10	<0.10	<0.10	<0.15	<0.10	<0.05

Table C3. Polychlorinated biphenyls (continues)
Pago Pago Harbor fish muscle tissues
Units = mg/Kg tissue wet weight.

Batch:	[10]	[12]	[13]	[14]	[14]	[15]	[16]
Date:	DUP	10/90	10/90	1/91	DUP	1/91	1/91
Aroclor							
1016	<0.15	<0.15	<0.15	<0.1	<0.1	<0.1	<0.1
1221	<0.40	<0.40	<0.40	<0.1	<0.1	<0.1	<0.1
1232	<0.30	<0.30	<0.30	<0.1	<0.1	<0.1	<0.1
1242	<0.25	<0.25	<0.25	<0.1	<0.1	<0.1	<0.1
1248	<0.10	<0.10	<0.10	<0.1	<0.1	<0.1	<0.1
1254	<0.05	<0.05	<0.05	<0.1	<0.1	<0.1	<0.1
1260	<0.05[1]	<0.05	<0.05	<0.1[2]	<0.1	<0.1	<0.1

[1] - spike recovery for aroclor 1260 was 82%
[2] - spike recovery for aroclor 1260 was 96%

Table C4. Polychlorinated biphenyls (PCB's)
Pago Pago Harbor fish liver tissues
Units = mg/Kg tissue wet weight.

Batch:	[5]	[6]	[7]	[7]	[8]	[9]
Date:	5/90	5/90	5/90	DUP	5/90	5/90
Aroclor						
1016	<0.50	<0.60	<0.50	<0.50	<0.50	<0.50
1221	<0.55	<0.80	<0.55	<0.55	<0.60	<0.55
1232	<0.55	<0.80	<0.55	<0.55	<0.60	<0.55
1242	<0.40	<0.60	<0.40	<0.40	<0.45	<0.40
1248	<0.60	<0.90	<0.60	<0.60	<0.65	<0.60
1254	<0.30	<0.45	<0.30	<0.30	<0.30	<0.30
1260	<0.30	<0.45	<0.30	<0.30	<0.30	<0.30

Table C4. Polychlorinated biphenyls (continues)
Pago Pago Harbor fish liver tissues
Units = mg/Kg tissue wet weight.

Batch:	[14]	[14]	[15]	[16]
Date:	1/91	DUP	1/91	1/91
Aroclor				
1016	<0.1	<0.1	<0.1	<0.1
1221	<0.1	<0.1	<0.1	<0.1
1232	<0.1	<0.1	<0.1	<0.1
1242	<0.1	<0.1	<0.1	<0.1
1248	<0.1	<0.1	<0.1	<0.1
1254	<0.1	<0.1	<0.1	<0.1
1260	<0.1[1]	<0.1	0.44	0.39

1 - spike recovery for aroclor 1260 was 96%.

APPENDIX E Polynuclear Aromatic Hydrocarbons (PAH)

Table E1. Polynuclear Aromatic Hydrocarbons (PAH)
Pago Pago Harbor sediments
Units: mg/Kg sediment wet weight

	Site 1	Site 1D	Site 2	Site 3	Site 4	Site 5
Acenaphthene	<7.0	<3.5	<3.5	<3.5	<7.0	<3.5
Acenaphthylene	<3.5	<3.5	<3.5	<3.5	<7.0	<7.0
Anthracene	<7.0	<3.5	<3.5	<3.5	<7.0	<3.5
Benzo(a)-anthracene	<3.5	<7.0	<3.5	<3.5	<7.0	<3.5
Benzo(a)-fluoranthene	<3.5	<3.5	<3.5	<7.5	<7.0	<5.0
Benzo(a)-pyrene	<3.5	<3.5	<3.5	<3.5	<7.0	<5.0
Benzo(ghi)-perylene	<3.5	<5.0	<5.0	<5.0	<12.0	<5.0
Benzo(k)-fluoranthene	<3.5	<3.5	<3.5	<3.5	<7.0	<5.0
Chrysene	<3.5	<7.0	<3.5	<3.5	<7.0	<3.5
Dibenzo(a,h)-anthracene	<5.0	<5.0	<5.0	<12.0	<12.0	<5.0
Fluoranthene	<7.0	<3.5	<3.5	<3.5	<7.0	<3.5
Fluorene	<3.5	<3.5	<3.5	<3.5	<7.0	<3.5
Indeno(1,2,3-c,d)pyrene	<3.5	<3.5	<3.5	<3.5	<7.0	<5.0
Naphthalene*	<3.5	<3.5	<3.5	<3.5	<7.0	<3.5
Phenanthrene	<3.5	<7.0	<3.5	<3.5	<7.0	<3.5
Pyrene	<3.5	<3.5	<3.5	<3.5	<7.0	<3.5

* Spike recovery for naphthalene (Site 1) was 66%

APPENDIX E Polynuclear Aromatic Hydrocarbons (PAH)

Table E2. Polynuclear Aromatic Hydrocarbons (PAH)
Pago Pago Harbor fish muscle tissues
Units: mg/Kg tissue wet weight

Batch: Date:	[1] 4/90	[1] DUP	[2] 4/90	[3] 4/90	[4] 4/90	[7] 4/90
Acenaphthene	<10.0	<5.0	<5.0	<10.0	<10.0	<10.0
Acenaphthylene	<10.0	<5.0	<5.0	<5.0	<5.0	<5.0
Anthracene	<10.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo(a)-anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo(a)-fluoranthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo(a)-pyrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo(ghi)-perylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo(k)-fluoranthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chrysene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dibenzo(a,h)-anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Fluoranthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Fluorene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Indeno(1,2,3-c,d)pyrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Naphthalene	<10.0	<5.0	<5.0	<5.0	<5.0	<5.0
Phenanthrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pyrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

APPENDIX E Polynuclear Aromatic Hydrocarbons (PAH)

Table E2. Polynuclear Aromatic Hydrocarbons (continues)
Pago Pago Harbor fish muscle tissues
Units: mg/Kg tissue wet weight

Batch: Date:	[10] 10/90	[10] DUP	[12] 10/90	[13] 10/90	Spike[1]
Acenaphthene	<0.5	<0.5	<0.5	<0.5	67%
Acenaphthylene	<1.0	<1.0	<1.0	<1.0	61%
Anthracene	<0.05	<0.05	<0.05	<0.05	72%
Benzo(a)-anthracene	<0.05	<0.05	<0.05	<0.05	91%
Benzo(a)-fluoranthene	<0.1	<0.1	<0.1	<0.1	78%
Benzo(a)-pyrene	<0.05	<0.05	<0.05	<0.05	85%
Benzo(ghi)-perylene	<0.1	<0.1	<0.1	<0.1	83%
Benzo(k)-fluoranthene	<0.05	<0.05	<0.05	<0.05	84%
Chrysene	<0.05	<0.05	<0.05	<0.05	85%
Dibenzo(a,h)-anthracene	<0.1	<0.1	<0.1	<0.1	80%
Fluoranthene	<0.1	<0.1	<0.1	<0.1	75%
Fluorene	<0.1	<0.1	<0.1	<0.1	66%
Indeno(1,2,3-c,d)pyrene	<0.05	<0.05	<0.05	<0.05	85%
Naphthalene	<0.5	<0.5	<0.5	<0.5	32%
Phenanthrene	<0.05	<0.05	<0.05	<0.05	74%
Pyrene	<0.05	<0.05	<0.05	<0.05	111%

1 - Spike recovery (%) for a batch [10] sample.

Table E2. Polynuclear Aromatic Hydrocarbons (continues)
Pago Pago Harbor fish muscle tissues
Units: mg/Kg tissue wet weight

Batch: / Date:	[14] 1/91	[14] DUP	[15] 1/91	[16] 1/91	Spike[1]
Acenaphthene	<1.0	<1.0	<1.0	<1.0	41%
Acenaphthylene	<1.0	<1.0	<1.0	<1.0	40%
Anthracene	<1.0	<1.0	<1.0	<1.0	--
Benzo(a)-anthracene	<1.0	<1.0	<1.0	<1.0	47%
Benzo(a)-fluoranthene	<1.0	<1.0	<1.0	<1.0	47%
Benzo(a)-pyrene	<1.0	<1.0	<1.0	<1.0	47%
Benzo(ghi)-perylene	<2.0	<2.0	<2.0	<2.0	52%
Benzo(k)-fluoranthene	<1.0	<1.0	<1.0	<1.0	50%
Chrysene	<1.0	<1.0	<1.0	<1.0	53%
Dibenzo(a,h)-anthracene	<2.0	<2.0	<2.0	<2.0	53%
Fluoranthene	<1.0	<1.0	<1.0	<1.0	50%
Fluorene	<1.0	<1.0	<1.0	<1.0	39%
Indeno(1,2,3-c,d)pyrene	<1.0	<1.0	<1.0	<1.0	54%
Naphthalene	<1.0	<1.0	<1.0	<1.0	39%
Phenanthrene	<1.0	<1.0	<1.0	<1.0	41%
Pyrene	<1.0	<1.0	<1.0	<1.0	54%

1 - Spike recovery (%) for a batch [14] sample.

APPENDIX E Polynuclear Aromatic Hydrocarbons (PAH)

Table E3. Polynuclear Aromatic Hydrocarbons (PAH)
Pago Pago Harbor fish liver tissues
Units: mg/Kg tissue wet weight

Batch:	[5]	[6]	[7]	[7]	[8]	[9]
Date:	5/90	5/90	5/90	DUP	5/90	5/90
Acenaphthene	<16.0	<20.0	<18.0	<18.0	<20.0	<15.0
Acenaphthylene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Anthracene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Benzo(a)-anthracene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Benzo(a)-fluoranthene	<16.0	<20.0	<18.0	<18.0	<20.0	<15.0
Benzo(a)-pyrene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Benzo(ghi)-perylene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Benzo(k)-fluoranthene	<16.0	<20.0	<18.0	<18.0	<20.0	<15.0
Chrysene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Dibenzo(a,h)-anthracene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Fluoranthene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Fluorene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Indeno(1,2,3-c,d)pyrene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Naphthalene	<8.0	<14.0	<9.0	<9.0	<10.0	<7.5
Phenanthrene	<16.0	<20.0	<18.0	<18.0	<20.0	<15.0
Pyrene	<16.0	<20.0	<18.0	<18.0	<20.0	<15.0

Table E3. Polynuclear Aromatic Hydrocarbons (continues)
Pago Pago Harbor fish liver tissues
Units: mg/Kg tissue wet weight

Batch: Date:	[14] 1/91	[14] DUP	[15] 1/91	[16] 1/91	Spike[1]
Acenaphthene	<1.0	<1.0	<1.0	<1.0	35%
Acenaphthylene	<1.0	<1.0	<1.0	<1.0	43%
Anthracene	<1.0	<1.0	<1.0	<1.0	--
Benzo(a)-anthracene	<1.0	<1.0	<1.0	<1.0	42%
Benzo(a)-fluoranthene	<1.0	<1.0	<1.0	<1.0	52%
Benzo(a)-pyrene	<1.0	<1.0	<1.0	<1.0	58%
Benzo(ghi)-perylene	<2.0	<2.0	<2.0	<2.0	54%
Benzo(k)-fluoranthene	<1.0	<1.0	<1.0	<1.0	72%
Chrysene	<1.0	<1.0	<1.0	<1.0	52%
Dibenzo(a,h)-anthracene	<2.0	<2.0	<2.0	<2.0	57%
Fluoranthene	<1.0	<1.0	<1.0	<1.0	43%
Fluorene	<1.0	<1.0	<1.0	<1.0	44%
Indeno(1,2,3-c,d)pyrene	<1.0	<1.0	<1.0	<1.0	57%
Naphthalene	<1.0	<1.0	<1.0	<1.0	29%
Phenanthrene	<1.0	<1.0	<1.0	<1.0	45%
Pyrene	<1.0	<1.0	<1.0	<1.0	82%

1 - Spike recovery (%) for a batch [14] sample.

PAGO PAGO HARBOR

SEAWATER

VOLATILE ORGANICS
(ug/L)

	Site 1	Site 4	Detection Limit
Chloromethane	BDL	BDL	15
Bromomethane	BDL	BDL	15
Vinyl Chloride	BDL	BDL	15
Chloroethane	BDL	BDL	15
Methylene Chloride	BDL	BDL	15
Acetone	BDL	BDL	30
Carbon Disulfide	BDL	BDL	7.5
1,1-Dichloroethene	BDL	BDL	7.5
1,1-Dichloroethane	BDL	BDL	7.5
1,2-Dichloroethene,total	BDL	BDL	7.5
Chloroform	BDL	BDL	7.5
1,2-Dichloroethane	BDL	BDL	7.5
2-Butanone	BDL	BDL	30
1,1,1-Trichloroethane	BDL	BDL	7.5
Carbon Tetrachloride	BDL	BDL	7.5
Vinyl Acetate	BDL	BDL	15
Bromodichloromethane	BDL	BDL	7.5
1,2-Dichloropropane	BDL	BDL	7.5
cis-1,3-Dichloropropene	BDL	BDL	7.5
Trichloroethene	BDL	BDL	7.5
Benzene	BDL	BDL	7.5
Dibromochloromethane	BDL	BDL	7.5
1,1,2-Trichloroethane	BDL	BDL	7.5
trans-1,3-Dichloropropene	BDL	BDL	7.5
Bromoform	BDL	BDL	7.5
4-Methyl-2-pentanone	BDL	BDL	15
2-Hexanone	BDL	BDL	15
Tetrachloroethene	BDL	BDL	7.5
1,1,2,2-Tetrachloroethane	BDL	BDL	7.5
Toluene	BDL	BDL	7.5
Chlorobenzene	BDL	BDL	7.5
Ethylbenzene	BDL	BDL	7.5
Styrene	BDL	BDL	7.5
Xylenes (total)	BDL	BDL	7.5

BDL: Below Detection Limit DL: Detection Limit

PAGO PAGO HARBOR

SEAWATER

VOLATILE ORGANICS
(ug/L)

	SPIKE CONCENTRATION	% Recovery	Acceptance Window
1,1-Dichloroethene	50	78	61-145%
Trichloroethene	50	118	71-120%
Benzene	50	114	76-127%
Toluene	50	119	76-125%
Chlorobenzene	50	126	75-130%

ASG PAGO PAGO HARBOR

SEAWATER

VOLATILE ORGANICS
(ug/L)

Surrogates - Site 1	% Recovery	Acceptance Window
1,2-Dichloroethane-d4	91%	76-114%
Toluene-d8	95%	88-110%
4-Bromofluorobenzene	95%	86-115%

Surrogates - Site 1 dup.	% Recovery	Acceptance Window
1,2-Dichloroethane-d4	88%	76-114%
Toluene-d8	94%	88-110%
4-Bromofluorobenzene	95%	86-115%

Surrogates - Site 2	% Recovery	Acceptance Window
1,2-Dichloroethane-d4	94%	76-114%
Toluene-d8	94%	88-110%
4-Bromofluorobenzene	97%	86-115%

PAGO PAGO HARBOR

SEAWATER

VOLATILE ORGANICS
(ug/L)

	Site 1	Site 1 dup.	Site 2	Detection Limit
Chloromethane	BDL	BDL	BDL	10
Bromomethane	BDL	BDL	BDL	10
Vinyl Chloride	BDL	BDL	BDL	10
Chloroethane	BDL	BDL	BDL	10
Methylene Chloride	BDL	BDL	BDL	10
Acetone	BDL	BDL	BDL	20
Carbon Disulfide	BDL	BDL	BDL	5
1,1-Dichloroethene	BDL	BDL	BDL	5
1,1-Dichloroethane	BDL	BDL	BDL	5
1,2-Dichloroethene,total	BDL	BDL	BDL	5
Chloroform	BDL	BDL	BDL	5
1,2-Dichloroethane	BDL	BDL	BDL	5
2-Butanone	BDL	BDL	BDL	20
1,1,1-Trichloroethane	BDL	BDL	BDL	5
Carbon Tetrachloride	BDL	BDL	BDL	5
Vinyl Acetate	BDL	BDL	BDL	10
Bromodichloromethane	BDL	BDL	BDL	5
1,2-Dichloropropane	BDL	BDL	BDL	5
cis-1,3-Dichloropropene	BDL	BDL	BDL	5
Trichloroethene	BDL	BDL	BDL	5
Benzene	BDL	BDL	BDL	5
Dibromochloromethane	BDL	BDL	BDL	5
1,1,2-Trichloroethane	BDL	BDL	BDL	5
trans-1,3-Dichloropropene	BDL	BDL	BDL	5
Bromoform	BDL	BDL	BDL	5
4-Methyl-2-pentanone	BDL	BDL	BDL	10
2-Hexanone	BDL	BDL	BDL	10
Tetrachloroethene	BDL	BDL	BDL	5
1,1,2,2-Tetrachloroethane	BDL	BDL	BDL	5
Toluene	BDL	BDL	BDL	5
Chlorobenzene	BDL	BDL	BDL	5
Ethylbenzene	BDL	BDL	BDL	5
Styrene	BDL	BDL	BDL	5
Xylenes (total)	BDL	BDL	BDL	5

BDL: Below Detection Limit

DL: Detection Limit

PAGO PAGO HARBOR

SEDIMENT

VOLATILE ORGANICS
(ug/L)

SITE :	1	2	3	4	4d	Detectio Limit
Chloromethane	BDL	BDL	BDL	BDL	BDL	50
Bromomethane	BDL	BDL	BDL	BDL	BDL	50
Vinyl Chloride	BDL	BDL	BDL	BDL	BDL	50
Chloroethane	BDL	BDL	BDL	BDL	BDL	50
Methylene Chloride	BDL	BDL	BDL	BDL	BDL	50
Acetone	BDL	BDL	BDL	BDL	BDL	100
Carbon Disulfide	BDL	BDL	BDL	BDL	BDL	25
1,1-Dichloroethene	BDL	BDL	BDL	BDL	BDL	25
1,1-Dichloroethane	BDL	BDL	BDL	BDL	BDL	25
1,2-Dichloroethene, total	BDL	BDL	BDL	BDL	BDL	25
Chloroform	BDL	BDL	BDL	BDL	BDL	25
1,2-Dichloroethane	BDL	BDL	BDL	BDL	BDL	25
2-Butanone	BDL	BDL	BDL	BDL	BDL	100
1,1,1-Trichloroethane	BDL	BDL	BDL	BDL	BDL	25
Carbon Tetrachloride	BDL	BDL	BDL	BDL	BDL	25
Vinyl Acetate	BDL	BDL	BDL	BDL	BDL	50
Bromodichloromethane	BDL	BDL	BDL	BDL	BDL	25
1,2-Dichloropropane	BDL	BDL	BDL	BDL	BDL	25
cis-1,3-Dichloropropene	BDL	BDL	BDL	BDL	BDL	25
Trichloroethene	BDL	BDL	BDL	BDL	BDL	25
Benzene	BDL	BDL	BDL	BDL	BDL	25
Dibromochloromethane	BDL	BDL	BDL	BDL	BDL	25
1,1,2-Trichloroethane	BDL	BDL	BDL	BDL	BDL	25
trans-1,3-Dichloropropene	BDL	BDL	BDL	BDL	BDL	25
Bromoform	BDL	BDL	BDL	BDL	BDL	25
4-Methyl-2-pentanone	BDL	BDL	BDL	BDL	BDL	50
2-Hexanone	BDL	BDL	BDL	BDL	BDL	50
Tetrachloroethene	BDL	BDL	BDL	BDL	BDL	25
1,1,2,2-Tetrachloroethane	BDL	BDL	BDL	BDL	BDL	25
Toluene	BDL	BDL	BDL	BDL	BDL	25
Chlorobenzene	BDL	BDL	BDL	BDL	BDL	25
Ethylbenzene	BDL	BDL	BDL	BDL	BDL	25
Styrene	BDL	BDL	BDL	BDL	BDL	25
Xylenes (total)	BDL	BDL	BDL	BDL	BDL	25

BDL: Below Detection Limit DL: Detection Limit

PAGO PAGO HARBOR

SEDIMENT

VOLATILE ORGANICS
(ug/L)

SITE :	5	6	Detection Limit
Chloromethane	BDL	BDL	50
Bromomethane	BDL	BDL	50
Vinyl Chloride	BDL	BDL	50
Chloroethane	BDL	BDL	50
Methylene Chloride	BDL	BDL	50
Acetone	BDL	BDL	100
Carbon Disulfide	BDL	BDL	25
1,1-Dichloroethene	BDL	BDL	25
1,1-Dichloroethane	BDL	BDL	25
1,2-Dichloroethene, total	BDL	BDL	25
Chloroform	BDL	BDL	25
1,2-Dichloroethane	BDL	BDL	25
2-Butanone	BDL	BDL	100
1,1,1-Trichloroethane	BDL	BDL	25
Carbon Tetrachloride	BDL	BDL	25
Vinyl Acetate	BDL	BDL	50
Bromodichloromethane	BDL	BDL	25
1,2-Dichloropropane	BDL	BDL	25
cis-1,3-Dichloropropene	BDL	BDL	25
Trichloroethene	BDL	BDL	25
Benzene	BDL	BDL	25
Dibromochloromethane	BDL	BDL	25
1,1,2-Trichloroethane	BDL	BDL	25
trans-1,3-Dichloropropene	BDL	BDL	25
Bromoform	BDL	BDL	25
4-Methyl-2-pentanone	BDL	BDL	50
2-Hexanone	BDL	BDL	50
Tetrachloroethene	BDL	BDL	25
1,1,2,2-Tetrachloroethane	BDL	BDL	25
Toluene	BDL	BDL	25
Chlorobenzene	BDL	BDL	25
Ethylbenzene	BDL	BDL	25
Styrene	BDL	BDL	25

BDL: Below Detection Limit DL: Detection Limit

PAGO PAGO HARBOR

SEDIMENT

GRAIN SIZE

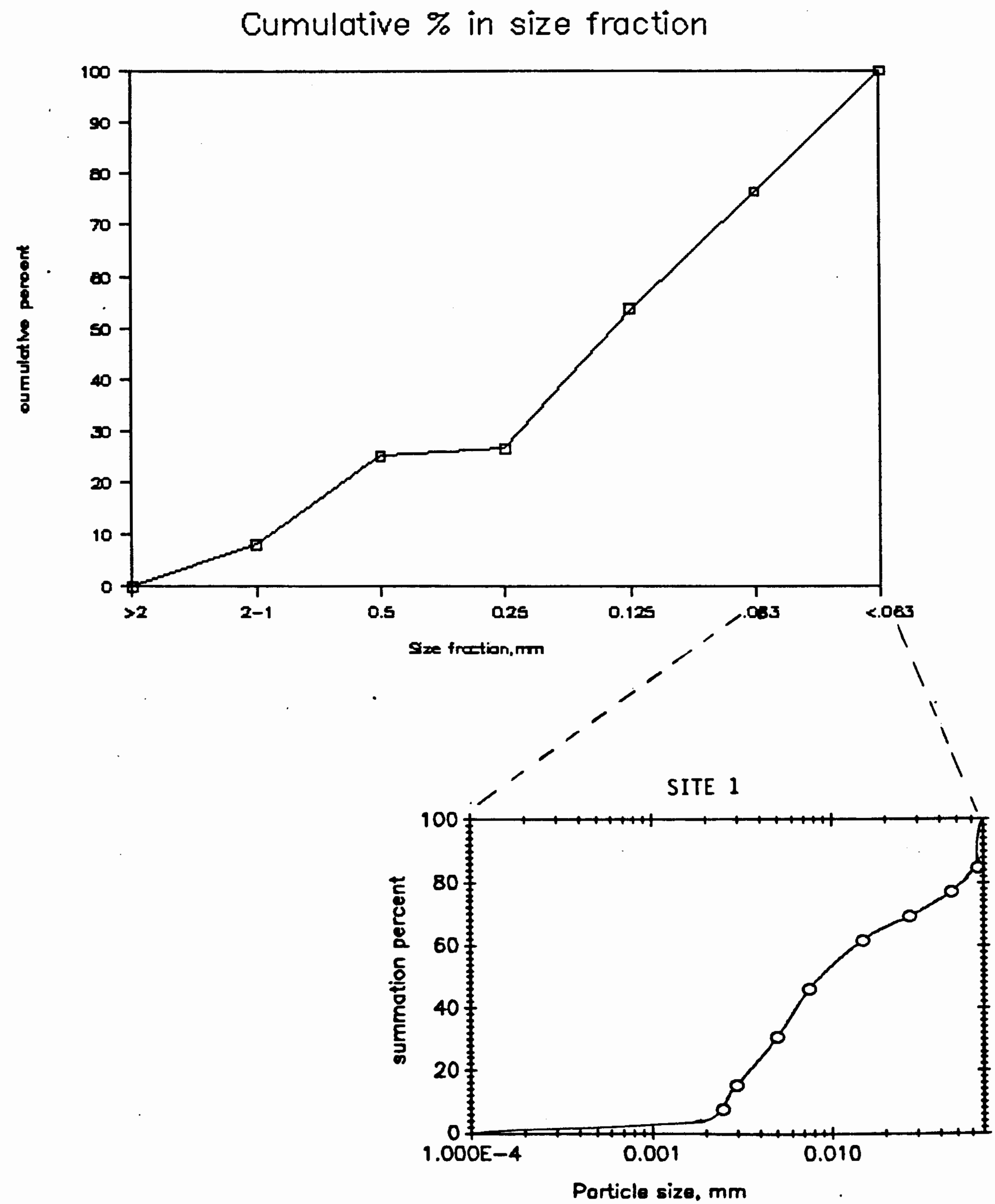
(% in size fraction)

(mm)	>2.0	2.0-1.0	1.0-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063
Site 1	-	8.1	17.0	1.4	27.2	22.8	23.5
Site 2	-	11.2	9.2	0.5	34.6	28.1	16.4
Site 3	2.1	5.1	8.1	2.4	49.4	26.3	6.6
Site 3D	0.1	0.6	1.9	11.4	18.8	13.4	53.8
Site 4	0.3	0.5	3.2	10.0	16.8	13.8	55.4
Site 5	0.5	10.9	29.5	12.8	35.3	15.9	5.0
Site 6	11.0	3.5	5.9	7.9	3.4	38.9	29.4

PAGO PAGO HARBOR

SEDIMENT

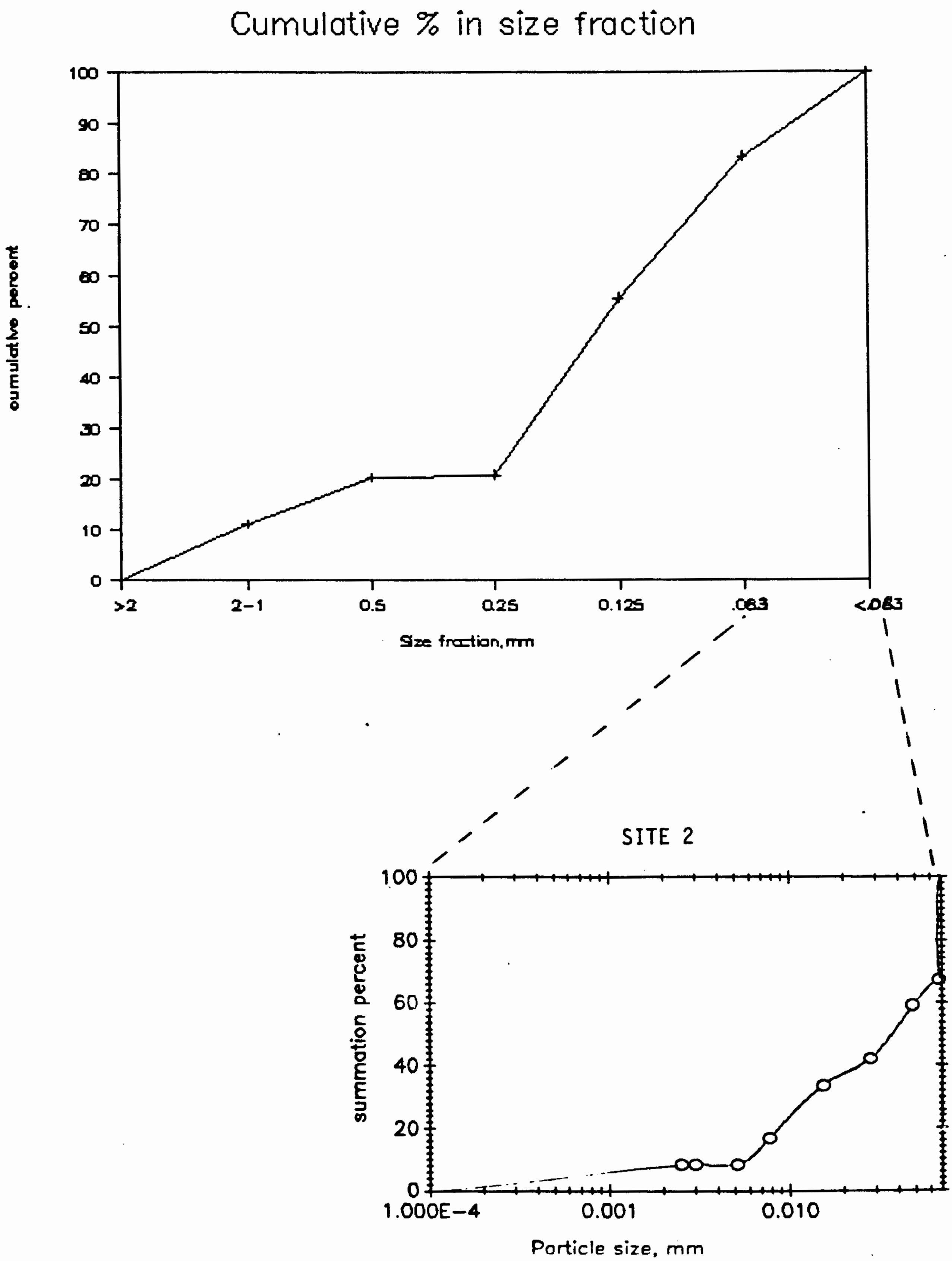
SITE 1



PAGO PAGO HARBOR

SEDIMENT

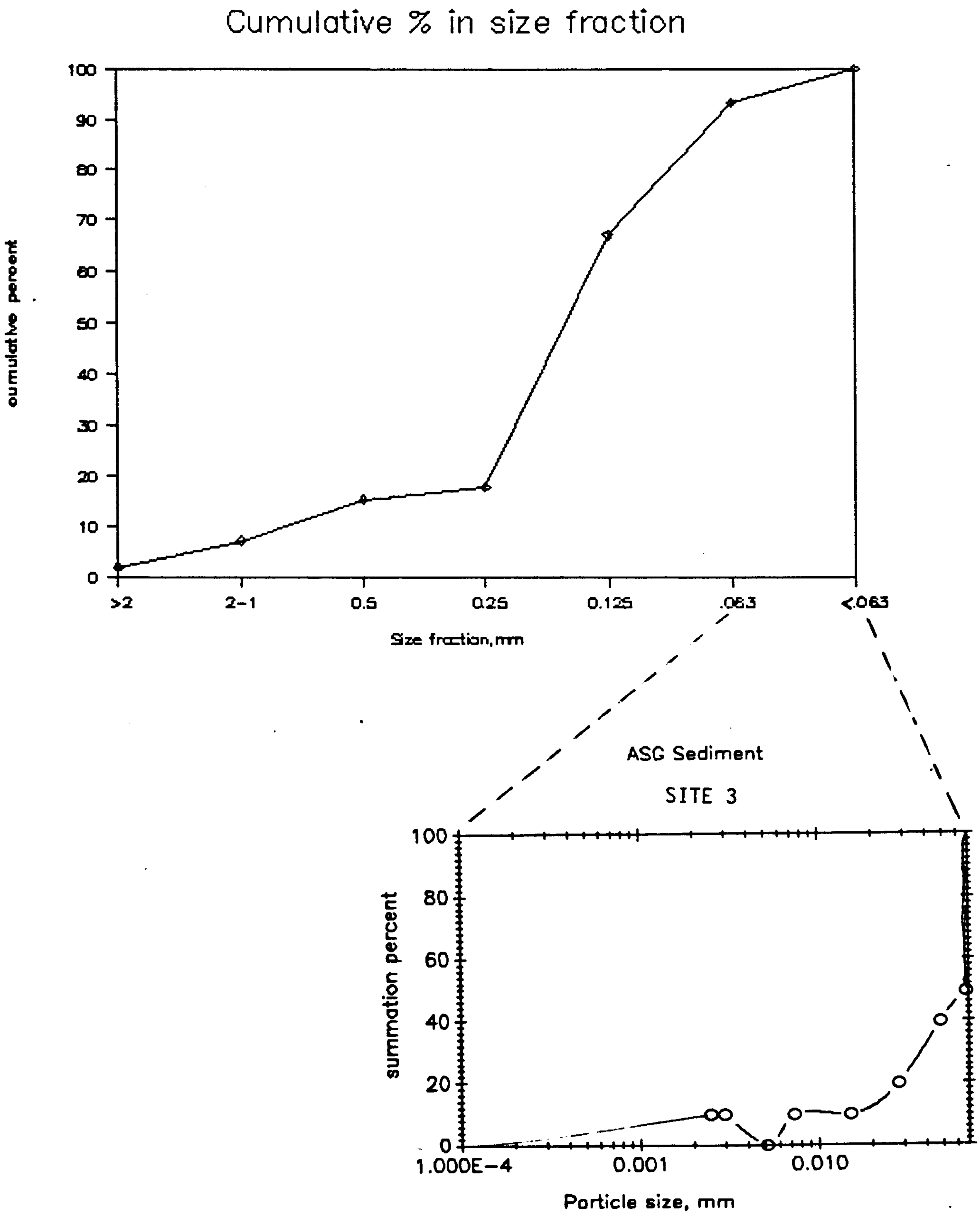
SITE 2



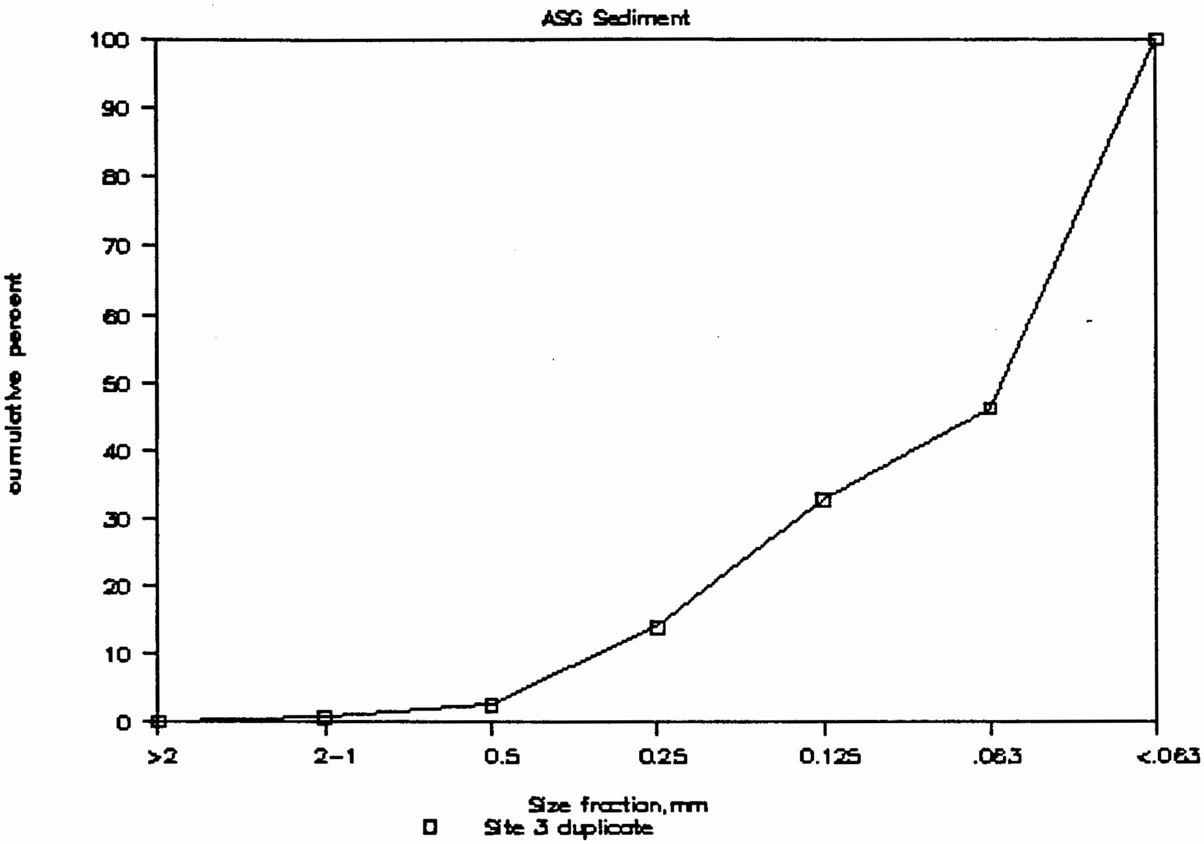
PAGO PAGO HARBOR

SEDIMENT

SITE 3



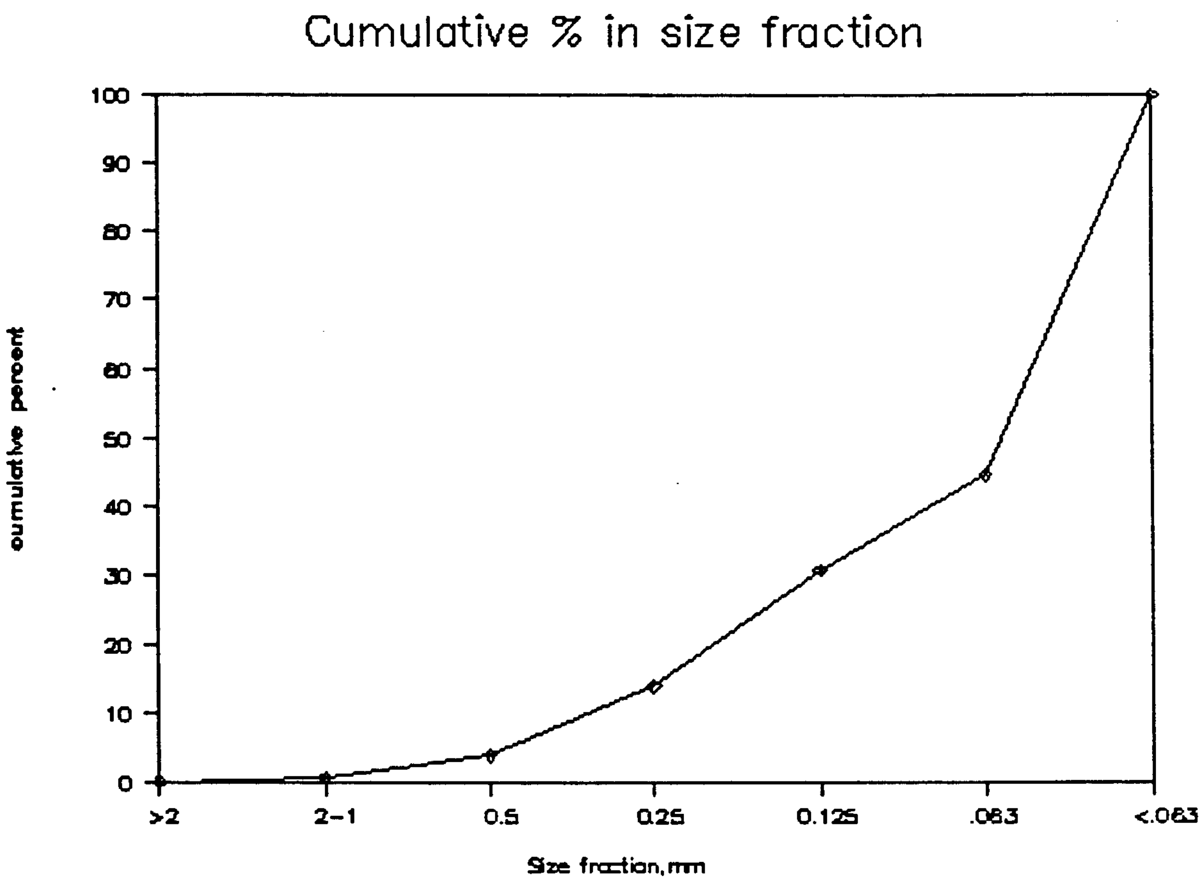
Cumulative % in size fraction



PAGO PAGO HARBOR

SEDIMENT

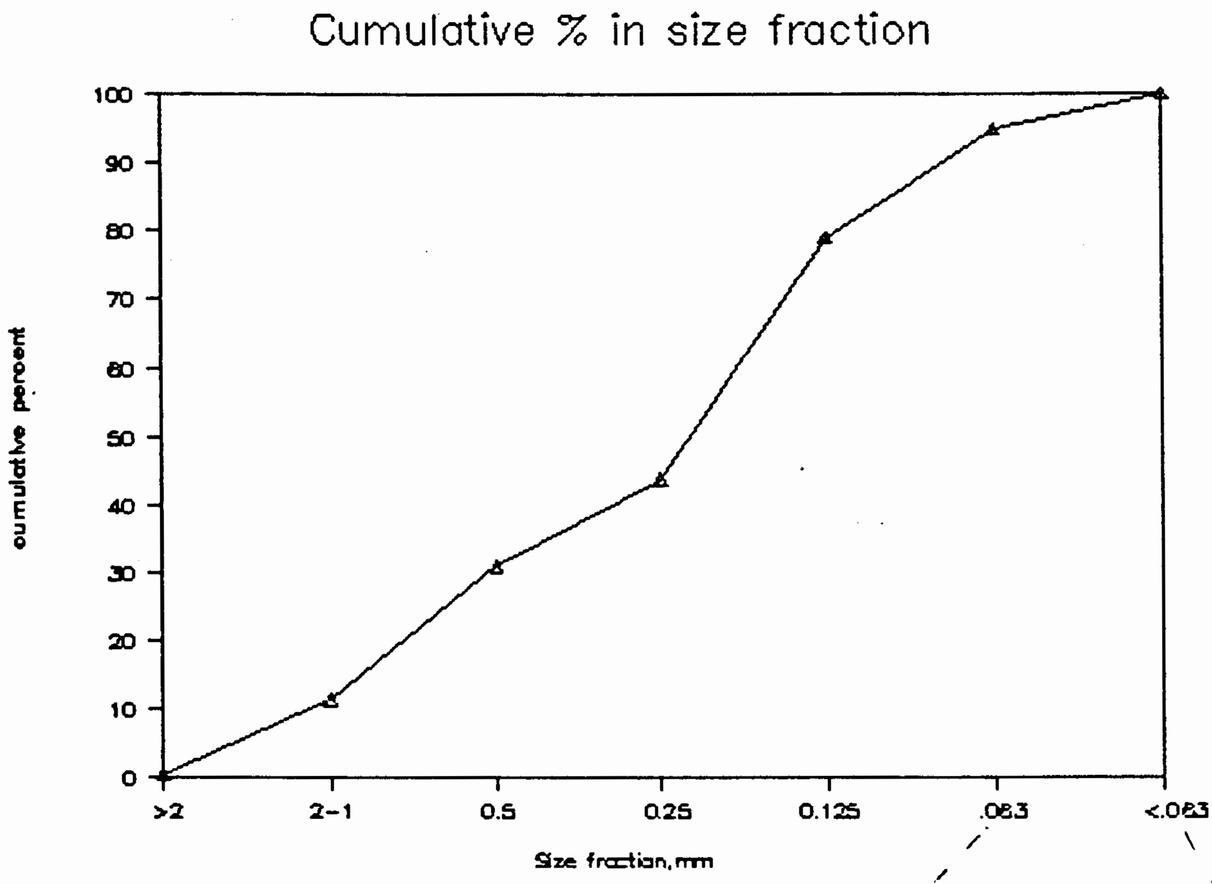
SITE 4

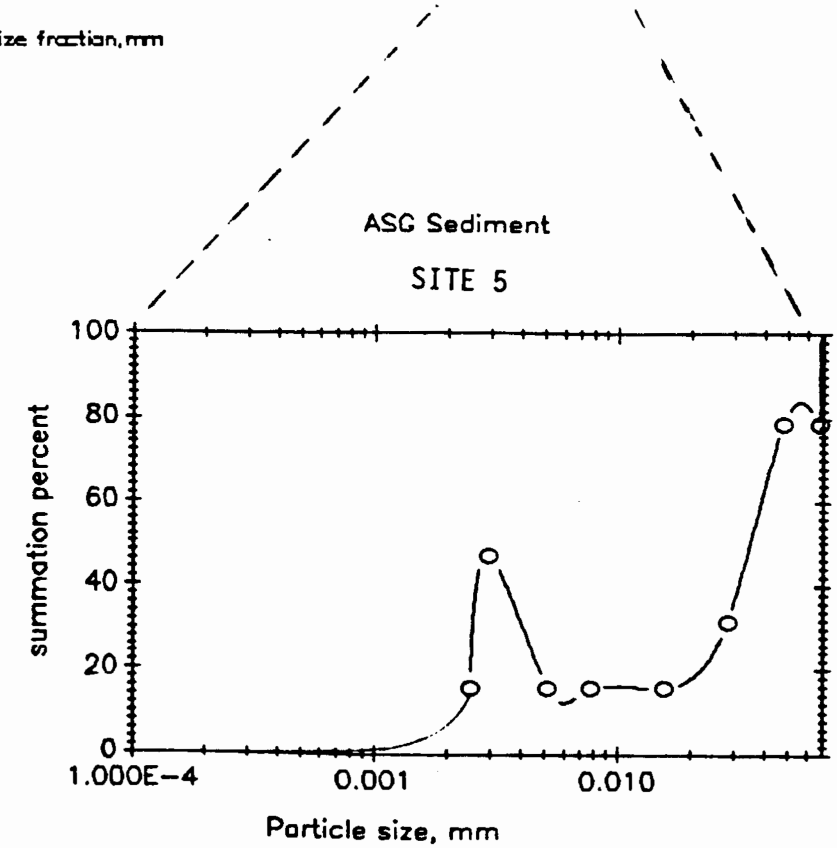


PAGO PAGO HARBOR

SEDIMENT

SITE 5





PĀGO PAGO HARBOR

SEDIMENT

SITE 6